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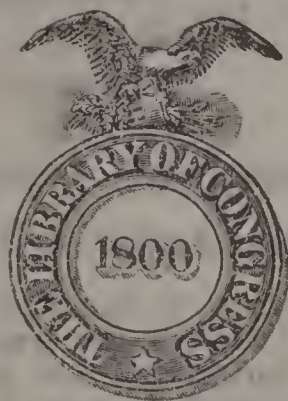
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Examination Questions

FOR

Dyke's Home Study Course

OF

Automobile Engineering

By

A. L. DYKE

Assisted by MR. A. W. RHEIN

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Preface.

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One of the Chief Advantages of Dyke's Home Study Course of Automobile Engineering is in the Examination Questions. The student answers the examination questions by writing them down.

Even though you do nothing more than copy the answers to the questions and write them down, you would learn more than you would by merely reading a book, because you would memorize the answers to the principal points (or, just what you ought to know) while writing.

It will be to your advantage, however, to write the answers from memory, after studying each instruction.

These questions are especially prepared in order to bring out the principal features of each subject, and if the questions are answered seriatim you will advance step by step, in a progressive, accumulative manner, as you should.

The Models.

These models are made solely for instruction purposes. They are of no value otherwise. Wait until you are into the subjects of engine valves, valve timing, firing orders, etc., and you will then begin to appreciate their real value.

A Few Practical Pointers You Should Always Remember.

THINK before you ACT. There is no profession today which one should take more pains to cultivate the habit of **thinking first—before acting**, than the profession of an automobile repairman and a surgeon. A surgeon might operate on a person for something that did not require operation—if he acted before thinking—and just so with the automobile repairman.

Remember that most bolts and nuts have right-handed threads, some have left-handed threads; if so, it is there for a purpose—**THINK**.

Remember that a large monkey wrench on a small nut may result in breaking something, as the leverage is much greater.

Remember that bolts and nuts of the same size may look alike, but may have different threads. To "cross thread" a nut on a bolt is an unpardonable sin.

Remember that pliers are not intended to be used where a wrench is

supposed to be used. They are made for different work.

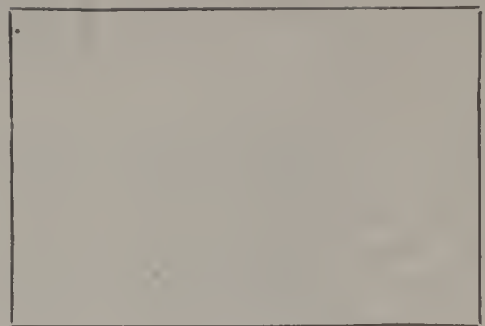
Remember that all parts are intended to fit in place easily and are not to be forced.

Remember that all nuts should be drawn snug, but also remember that many a water manifold flange has been cracked by drawing the nut too tight. I could continue with this kind of advice for many pages more, but it is not necessary as you now know what I mean by **Thinking Before You Act**—don't you think so?

Remember that when you remove parts of an engine, if these parts are replaced wrong—well, you know the answer. Adopt some system of working and have a box or pan for each lot of parts.

Remember that **order** and **system** is the first step to success and spells efficiency, and efficiency saves dollars. If you don't know the full meaning of these two words, find a dictionary and learn the meaning right now.

Instructions to the Student.



Your enrollment number is stamped in this square

WHEN WRITING OR ANSWERING QUESTIONS, PUT YOUR NAME, ADDRESS AND THIS ENROLLMENT NUMBER, ALSO YOUR INSTRUCTION NUMBER AT THE TOP OF EACH INSTRUCTION PAGE. DON'T FAIL TO DO THIS, OTHERWISE YOUR PAPERS WILL BE DELAYED.

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Write on plain paper, light weight as possible, and with ink or typewriter. Be sure and put your name, address, etc., as per above.

In order to answer the questions intelligently, make a careful study of the Instructions, and when you feel fairly sure that you understand, try to answer the questions without assistance. Answer as many as possible without referring to instruction, only using it for further study when it is absolutely necessary.

Each Instruction must be thoroughly understood before proceeding to the next. My advice is to read the instruction through and learn the names of all the parts, and then study and answer the questions on going over it the second time.

We do not expect every word and sentence to be absolutely correct; we simply want to know that you understand the principle or the idea—that's all.

The first few instructions are for the man who never saw the inside of an automobile, yet the most expert will find valuable information on practically every point touched. When you get to No. 7 lesson you will find every word of growing interest and value.

You can't judge the Course by looking it over, get into the reading matter.

Dictionary and Index: It is advisable for the student to refer to both, where words and terms are not clear.

Don't get in a hurry, take time, cultivate patience, set a time to do this work and concentrate on it properly and you will be well rewarded in the long run.

How to Answer the Examination Questions.

Don't write the question, merely the answer, but be sure and put the number of question down.

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It will save considerable time and make the question easier to answer, and for you to understand the answer—if you will oblige us by asking one question at the time, and place a number before the question, as, Question No. 1; then leave space for the answer to be written. Another point to observe in asking questions is, that you ask for the answer on that part of the subject you don't understand. Don't ask us to answer all of the question when it is answered in the text book, probably much clearer than we could answer it by a letter. Make an effort to answer it yourself and then, if you must, ask the question on the part which bothers you. These questions are for you to answer—not us.

If you don't answer some of the questions but leave it blank, we will assume that you did not look it up and it will be returned to you unanswered by us. If the answer cannot be found, refer to the index and text book.

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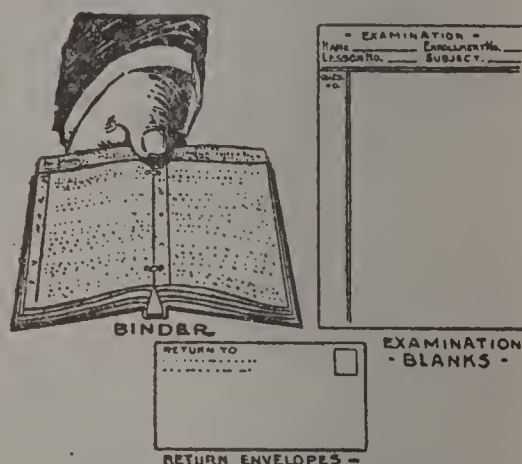
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When you get actually into the business of repairing or operating a car, you will, no doubt, have occasion to refer to various subjects.



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5—How is electricity transmitted from its source back again?.....206

6—What is used to transmit the electricity from its source back again?.....206

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8—If the circuit is broken will the flow of electricity stop?.....206

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10—What is the wire called by which it returns?.....206

11—If these wires were bare and they touched, or if there was a lead from the wire to some metallic substance, what would this be termed?.....207

12—What is a “conductor”?.....207

13—What metal is the best conductor?.....207

14—What metal is next best conductor?.....207

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27—Make a sketch showing 6 dry cells connected in “multiple series”.....209, 214

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48—What are “secondary cells”?.....211

49—How are “dry cells” made?.....211

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53—How would you tell the positive and negative terminals of a storage battery
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60—About how many volts does each cell of a storage battery give?.....212

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62—How can a storage battery be recharged?.....327, 337

63—How is electrolyte made?.....212

64—What instrument is used to determine the correct solution?.....212

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67—What does a mechanical generator of electricity consist of.....212, 256

68—How can the “field poles” be constructed?.....212, 256

- 69—When the “magnetic field” is produced by a “permanent magnet,” is this type usually a **magneto**, generating “alternating current”?.....212, 256
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- 70—When magnetic field is produced by an “electro-magnet” is this generator called a dynamo? 212
- 71—If armature is a “shuttle” type, would the current generated be alternating”? 212, 256
- 72—If armature is a “drum” type would the current generated be “direct” current? 212, 256
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- 77—Are “alternating current generators” divided into two classes? if so, name them. 257
- 78—What is meant by a “grounded terminal” of a generator of electricity?.....213
- 78a—What is the object or advantage of a grounded terminal?.....213
- 79—Can the frame of car be used for the “return wire”?.....213
- 80—Which terminal of a generator of electricity can be “grounded”? (foot-note).213
- 81—If you saw the letter “G” or “GRND” on a coil, would you know that this terminal of coil was to be grounded?.....213
- 82—How can the ignition of an engine be started from batteries and then run with a dynamo or magneto?.....213
- 83—Name the two systems of electric ignition.....213
- 84—What does the word “tension” mean?.....213
- 85—Is the low tension ignition system now in general use?.....213
- 86—Which system is in general use?.....213
- 87—Name the different kinds of “low tension” systems.....213
- 88—Name the different kinds of “high tension” systems.....213
- 89—How is a “low tension” or “primary coil” constructed?.....215
- 90—Explain its action.....215
- 91—Explain the action and how the low tension “make and break” system is used to ignite the compressed gas in a gasoline engine.....215, 214
- 92—Make a sketch of a low tension “make and break” ignition system on a single cylinder engine using a storage battery for source of electric current.....214
- 93—What operates the “igniter”?.....214
- 94—When should the igniter make the spark?.....315
- 95—Could either “dry cells,” “storage battery” or “direct current generator” be used as a source of electric supply?.....214, 217
- 96—Make a sketch of a four-cylinder engine using a “make and break” ignition system, using dry cells to start on and a dynamo to run on.....216
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- 99—Explain the action of a “wipe spark”.....215
- 100—What type of engine is it usually used on? (foot-note).....215

INSTRUCTION No. 17.

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3—Name the parts of a spark plug?.....218

4—Where are spark plugs used on gasoline engines? (foot-note).....219

5—How are they constructed?.....219, 218

6—Is the center wire or “electrode” of a spark plug connected with the electric current and is the “shell” of spark plug insulated from the center wire?..219, 218

7—How is the center wire insulated from the shell?.....219, 218

8—Then the metal part of engine is used for the return circuit is it not?.....219, 218

9—Is there a “gap” between the center wire and wire on iron shell (S), fig. 3, page 218, when assembled and screwed into cylinder?.....218

10—Then how will the electric current jump the “gap” and produce a spark?.218, 219

11—Explain the construction of a “high tension coil”.....219

11a—How is electricity “induced”.....223

12—What parts of a high tension coil connect with the “primary winding” of the “high tension coil”?.....218

13—What is the “commutator” for and how driven?.....218, 222

14—When the contact is made by the “roller” of commutator revolving, then the circuit is closed between the battery and primary wire of coil, is it not?..218, 220

15—Then what happens?.....219, 220, 221

16—When current flows through the primary winding of coil, although the secondary winding is not connected with the primary, but merely wound around it, is there a “high tension” or “high voltage” current produced in the secondary winding sufficiently strong enough to jump the gap of the spark plug points? 219, 220, 221

17—What do the two ends of the secondary wires of coil connect with.....218

18—How is the current “induced” in the secondary winding?.....219, 221, 223

19—What is the object of a “vibrator” on a coil?.....220

20—Explain its action.....220

21—Suppose there were no vibrator on the coil, would it be necessary to use a commutator or timer similar to fig. 2, page 220? Why?.....225

22—Then the coil with a vibrator is called a “magnetic type of vibrator,” is it not? And a commutator which would make a “wiping” or “roller” contact, would be necessary to use with it, would it not?.....225

23—If the “mechanical vibrator” is used (as in fig. 2, page 220), then by using this device instead of a commutator a non-vibrating coil would be used, would it not? 223

24—If a coil with a “magnetic type of vibrator” were used, would there be a “succession of sparks” at the spark plug gap?.....225

25—If a non-vibrating coil is used with a mechanical vibrator, would there be a “succession” or a “single spark”?.....223, 225

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28—What is a “commutator segment” for and how many segments are there to a 1, 2, 4 or 6-cylinder engine?.....227, 226

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29a—What part of the commutator revolves and what is its revolving part connected to?.....222, 227

- 30—How many revolutions does revolving part of commutator make to two revolutions of crankshaft on a 1, 4 and 6 cylinder engine.....227
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- 32—What is the difference between a “timer” and a “commutator”?.....225
- 33—Are timers (also called interrupters) made so that they “open” the circuit to produce the spark?.....225, 243
- 33a—If so, what are they termed?.....225
- 34—Are timers made so that they “close” the circuit to produce the spark?...225, 243
- 34a—If so, what are they termed?.....225
- 35—Do both “closed” and “open” circuit timers produce a “single spark” and are they generally used with “non-vibrating coils”?.....225, 243
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- 8—If gears are used to drive the magneto, then they should not be meshed too tight, as undue strain would result on bearings. Is this a fact? Yes.
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- 84—Suppose you had spark advanced full and were running at high speed and came to a hill where engine slows down considerably, would piston be coming up or going down, when ignition took place, and what would be the result?..319
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- 90—If a six-cylinder engine was marked “DC1-6,” what would this mean, and why? 320
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- 3—Was this method always reliable?.....321
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- 24—Does a great quantity of current pass through the brushes when starting an engine with a starting motor?.....325
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- 40—What method is used to charge a storage battery when it has exhausted its current? 327
- 41—What is meant by a “multi-polar” and “bi-polar” type field pole?.....328
- 42—Explain the principle and action of the Bendix automatic principle of starting 326, 331
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INSTRUCTION No. 27.

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- 1—Do the words “dynamo” and “generator” (referred to in this instruction), mean the same thing? (foot-note).....333
- 2—Is an electric generator similar in many respects to an electric motor?....333
- 3—In what respect do they differ?.....333
- 4—Could a “series,” “shunt” or “compound wound” generator operate as a motor? 333
- 5—Name the parts of a dynamo or generator.....333, 335
- 6—What is a generator used for on an automobile (in addition to charging the battery)? 333, 335
- 7—Is the current generated, direct or alternating?.....333, 335
- 8—Would alternating current charge a storage battery?.....335, 447
- 9—What kind of windings are there on a generator of the type we propose using for charging the storage battery on a car?.....335
- 10—What does the word “shunt” mean?.....335
- 11—Into how many classes are direct current dynamos or generators divided...335
- 11a—In what manner do they differ?.....335
- 12—What part of a generator is the “field core”?.....335
- 13—In what two ways can the “magnetic field” be produced?.....335
- 14—Which of the two is the most popular?.....335
- 15—What manner of winding has the armature of a direct current generator?..335
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- 17—When operated by a silent chain, state the different methods employed to adjust the tension of chain.....728
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- 19—What amount of free movement should chain have?.....728
- 20—Explain the principle of the “Morse adjustable sprocket” used with that make of silent chain.....728
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- 22—When engine is running at seven to ten miles, or over (car speed), from what source is the current for lights, ignition and current to charge the battery obtained?.....337

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34—Would the amperage or quantity of current increase also?.....337

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40—What different systems of regulation may be termed the inherent or “constant current” regulation control?.....343

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42—Explain the principle of “bucking series” regulation.....345

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44—For what purpose is the “shunt field winding” S.H.F.?.....345

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- 57—How does a “voltage regulator,” or “regulating unit,” as it is sometimes called, operate? Explain its action.....925, 345
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- 60—What is the difference between a “constant current” regulated generator and a “constant voltage” regulated generator?.....925, 343
- 61—How would you adjust to “increase the voltage” of a “voltage regulated generator”? 925
- 62—How would you adjust to increase the “output” of a “constant current regulated generator,” using the “third-brush” regulation?.....925
- 63—Briefly explain what takes place when “starting-pedal” is depressed on starting and generating system, shown on page 338, engine supposed to idle....338
- 64—Where did starting motor obtain its current to start engine?.....338
- 65—Where did engine obtain current for ignition to start?.....338
- 66—After engine is started and running at a speed of nine or ten miles per hour, car speed, what action takes place?.....338
- 67—Where does the ignition system of engine then obtain current?.....338
- 68—Does generator start to charge battery at that time?.....338
- 69—When engine is running at a very high speed, what device prevents the generator from generating an excessive high voltage?.....338
- 70—Would this method of regulation be termed a “voltage regulation” method?..338
- 71—What is the difference between the starting motor method of starting engine on page 342 to that on page 338?.....342, 338
- 72—From what part of engine is generator usually driven?.....341
- 73—What is meant by an “over-running generator clutch,” and where and when is it used?.....341
- 74—What kind of a clutch is a “roller type,” and where and when is it used?..341
- 75—Could the distributor and timer, or “ignition unit,” as it is termed, be mounted on the generator?.....341, 342
- 76—How would it be necessary to drive it?.....341
- 77—What is meant by a “single unit” starting motor, generator and ignition system? 340, 343
- 78—What is meant by a “two-unit” starting motor, generator and ignition system? 340, 343
- 79—What is meant by a “three-unit starting motor, generator and ignition system? 340, 343
- 80—How could the “two-unit” system be arranged?.....340, 343
- 81—How could the “three-unit” system be arranged?.....340, 343
- 82—Why is the term “magneto” ignition sometimes referred to when the system is a coil and battery system and direct current only is used?.....341
- 83—Is the “starting, generating and ignition system” explained on pages 343 and 342 a two-unit system?.....341, 342
- 84—Name the different parts which make up this system.....341, 342
- 85—What voltage is required for starting motor?.....343, 342
- 86—What make and type of drive is used with this starting motor?.....343, 342
- 87—What kind of starting switch is there used?.....343
- 88—Explain the method of starting, and what takes place?.....343

89—After engine starts, what occurs?.....	343
90—Where does generator current go when car speed is ten miles or more per hour?	343
91—What purpose does the “automatic cut-out” serve?.....	343
92—What purpose does the “regulator” serve?.....	343
93—What type of “regulator” is this called?.....	343
94—What is the difference between the “regulator” and “cut-out”?.....	343
95—What is meant by the “controller”?.....	343
96—What is meant by a “reverse current cut-out”?.....	344, 342, 348
97—Name the parts of the Westinghouse starting, generating and ignition system	346, 347
98—Why is the regulator used with this system called the “inherent” system?	346, 343
98a—Are the terms “relay” and “cut-out” synonymous?.....	346
99—What parts make up the ignition system?.....	346, 347
100—How is the “ignition unit” driven?.....	346, 347
101—What is the “ballast resistor” for?.....	347, 348
102—What is meant by a “mechanical governor control”?.....	347
103—What does it control?.....	347
104—Explain the principle and drive method.....	347
105—What is the “roller clutch” for?.....	347
106—What is the clutch on governor of generator for?.....	347
107—Explain the action of the “mercury type regulator”.....	347
108—Does it cut-in and cut-out resistance into the field circuit?.....	347, 380
109—Can one armature serve for both the generator and the starting motor?....	347
110—Is it then called a “motor-generator”?.....	347, 352
111—Name the parts of the Entz motor-generator system.....	347, 352
112—Is the motor-generator converted into a generator above 600 revolutions per minute, and does it serve as a starting motor under 80 revolutions per minute?	352
113—Explain briefly how this is accomplished.....	352
114—Where is the U.S.L. “motor-generator” placed on an engine?.....	347, 353
115—How many windings has the field?.....	353
116—What is the action when used as a generator?.....	353
117—What is the action when used as a starting motor?.....	353
118—What is the voltage of this generator?.....	353
119—What kind of a regulation system has the U.S.L. 1914 generator? And explain its action	347, 353
120—What kind of a regulation system is there on the 1915 U.S.L. generator?..	353
121—What is the purpose of a fuse block?.....	348
122—What is a fuse?.....	428
123—Is the Westinghouse “timer” (or interrupter) a “closed” or “open” circuit type?	251, 252
124—Is the generating system shown on Page 349 a “voltage” regulated system?..	349
125—Explain the purpose, principle and action of the Remy regulation system shown on Page 350, and explain what the thermostat is for.....	350
126—Carefully study the Gray & Davis motor-generator system.....	354
127—Is this a two-unit system?.....	354
128—How is the starting motor applied to engine to start it?.....	354
129—Explain briefly the regulation method of generator.....	354

130—What is meant by a “grounded switch” system?.....	355
131—What is meant by a “grounded motor” system?.....	355

INSTRUCTION No. 28.

A Study of Leading Electric Starting and Generating Systems.

1—What is meant by electrical symbols?.....	356
2—What is meant by a single wire system?.....	356
3—What is meant by a two-wire system?.....	356
4—Make a sketch of the following electric symbols: Positive terminal, negative terminal, wires crossing, separate circuits, storage battery, dry cell.....	356
5—Make a sketch showing the designation for 6 volt, 3 cell battery.....	376
5a—Make a sketch showing two 12 volt batteries connected so they can be charged from a 12 volt generator.....	353
6—When making the symbol of a storage battery, do the long light lines represent “positive” and the short black lines “negative” terminals or plates? For instance, see lower left corner of fig. 1, page 391, and make a sketch to designate a 3 cell battery, assuming that one long line (positive) and one short line (negative) comprise a cell.....	391
7—Make a symbol which indicates a “ground connection” of a wire to engine or frame	356
8—Is the electric system on page 357 a “single” or “two wire” system?.....	357
9—Is it a “two” or “three unit” system?.....	357
10—Explain how you would proceed to “set the timer” on this system.....	357
11—How is the fly-wheel marked, and what do marks mean?.....	357
12—What make of generator and starting motor is there used on the Overland?..	358
13—What make of drive system is there used on the starting motor?.....	359
14—How is generator driven?.....	359
15—How is output of generator controlled?.....	359
16—What is the function of the “circuit breaker”?.....	359
17—What is the purpose of the “ammeter”?.....	359
18—Where is the “switch box” placed?.....	359
19—What does the first “switch button” at top of switch box control?.....	359
20—What does the second “switch button” control?.....	359
21—What do the third and fourth switch buttons control?.....	359
22—What use was made of the fifth switch button (in the old models)?.....	359
23—What make of ignition system is used?.....	359, 358, 254
24—What is the object of the “automatic ignition switch” or “thermostat” used with the Connecticut ignition system?.....	254, 358
25—Is this automatic switch or thermostat placed in the combination switch box of the Overland?.....	254
26—State distance the “breaker points” of interrupter and spark plug gap should be set.....	359
27—State briefly how you would time the ignition.....	359
28—Study the electric systems on pages 360 to 368 inclusive, and clearly get in your mind the method of regulation used with generator, the make of ignition system and the kind of starting motor drive used.	
29—What voltage does generator deliver to battery on the Maxwell “25” electric system?.....	367

30—What voltage does starting motor use from battery (when starting) on the Maxwell "25"?.....367

31—How many cells are there in this battery and what is the voltage of the combined cells?.....366

32—When six volts are given to the 12 volt battery by generator, how is this connection made so that the 6 cells are charged at 6 volts?.....366

33—What make of electric system does the Dodge use, and is it a single or two wire system?.....369, 370

34—Is the starting motor and generator combined in one unit and does one armature serve for both generator and starting motor?.....369

35—How is the motor generator driven?.....369

36—Briefly explain how the Dodge starter and generator chain is adjusted.....411

37—What voltage does the Dodge system employ, and how many cells to the battery? 369

38—What make of ignition system is used and where located and how driven?..369

39—What is "firing order" of engine, and what distance are spark plug gaps set?..369

40—Explain briefly how you would "time the ignition".....369

41—Is the regular type of "reverse current cut-out" (as described previously) used to connect and disconnect the battery?.....370

42—Is the "cut-out" enclosed in the housing of starting switch?.....923

43—How is the "output" of generator regulated, or what regulation method is used? 370

44—How would you alter the "charging rate" of generator to battery?.....370

45—What is the "charging rate in amperes"?.....923

46—Where is the fuse located in generator, and is it the first place to look in case of failure of current supply?.....924

47—Explain briefly the difference between the "constant voltage" regulated generator and the "constant current" regulated generator, as exemplified in the Bijur make.....925

48—How would you adjust the Bijur voltage regulator?.....925

49—How would you adjust the Bijur cut-out?.....925

50—How would you adjust the Bijur constant current regulator?.....925

51—Explain the action of the "thermostatic control" on the Remy system used on the Reo.....371

52—How does the starting motor connect with engine (to start) in this system?..371

53—What make and kind of ignition system is used on the Reo?.....372, 371

54—What is the maximum opening of breaker points and what is the proper spark plug gap?.....372

55—How would you set the ignition on the Remy-Reo?.....373

INSTRUCTION No. 28A.

*Delco Ignition Systems.

1—Explain the principle of the early form of Delco ignition system.....375

2—Is the Delco "relay" system similar to the "master vibrator" system, explained on page 230, and how does it differ?.....375

3—Is a "succession of sparks" given to start on and only a "single spark" to run on? If so, explain how.....375, 374

*The word "Delco" is the manufacturer's trade name, being the initial letters of their name, Dayton Engineering Laboratories Co., Dayton, Ohio.

- 4—What is the objection to the old style “commutator” for ignition?.....375
- 5—What device has now taken the place of the old style commutator for ignition? 375
- 6—Does the “timer” give a “single” or “succession” of sparks?.....375
- 7—Is only one coil used with a timer?.....375
- 8—Then, to use only one coil, it is necessary to have a distributor, is it not?.375, 374
- 9—Make a sketch, showing the 5 dry cells for source of electric supply, then a double wound high tension, non-vibrating coil. Connect the timer and distributor, showing how four spark plugs would be fired every 180 degree movement of crank shaft or 90 degree movement of brush B, figs. 3 and 4, page..374
- 10—Is the distributor usually placed over the timer, and is the timer and distributor brush (B) driven by the same shaft?.....374, 378
- 11—Is the timer-distributor shaft sometimes driven from cam shaft and at cam shaft speed?.....244, 254
- 12—Does the cam shaft turn one revolution to two revolutions of crank shaft?....99
- 13—Since timer distributor shaft revolves the same speed as cam shaft, how many revolutions does the distributor brush B, fig. 3, page 374, make while crank shaft makes two revolutions?.....99
- 13a—Consider this in degrees; while crank shaft is making two revolutions or 720 degrees, the distributor brush B, would make 360 degrees, or one revolution, would it not?.....99
- In other words, the idea is to impress the importance of knowing that the distributor brush (B) and timer cam (D) (page 374, figs. 3 and 4), on a coil and battery system always revolve at camshaft speed, or 1 revolution to two of crankshaft. Whereas with magneto ignition (page 295), the armature turns the same speed as crankshaft on a four-cylinder engine, but $1\frac{1}{2}$ times crankshaft speed on a six-cylinder engine (using a 2-lobe cam), due to the fact that the magneto armature makes only two sparks per revolution—however, the distributor on magneto always revolves one revolution to two of crankshaft.
- A little study of the subject will make it clear that on a timer we can place “lobes” on the cam, so that as many sparks as are desired can be made during one revolution of crankshaft, and on the distributor, we can place as many segments as there are cylinders. We can’t do this with the magneto contact breaker cam with only two lobes because the armature of magneto only gives two impulses per revolution (unless it is designed to give four, as explained farther on).
- Another point to bear in mind is that the crankshaft must always make two revolutions on a 1, 2, 4, 6, 8 or 12-cylinder engine (four cycle), in order to complete its cycle evolution (as explained on page 57).
- On some magnetos, however, such as magnetos for airplane work, explained on page 922, the armature is designed to give 4 sparks per revolution, therefore, if it gives 4 sparks per revolution it will give 8 sparks for two revolutions and by using a 4-lobe cam on the magneto contact breaker, there would be 8 sparks for two revolutions of armature and 2 revolutions of crankshaft, hence it would turn at crankshaft speed.
- 14—Would the timer circuit, figs. 3 and 4, page 374, be an “open” or “closed” circuit principle?.....374, 375
- 15—Explain the difference between the “open-circuit” and “closed circuit” type interrupter of the “Delco” make?.....378
- 16—How is the adjustment of contact points made on Delco “closed-circuit-timer” fig. 7?.....378
- 17—To adjust the “open-circuit-timer,” fig. 6, it would be necessary to have breaker arm off the cam lobe, would it not? Yes.
- 18—What gap or distance is this space when properly adjusted?.....378
- 19—Express in writing, the following dimension (.020 inch).....541
- 20—What tool is best suited to measure these distances?.....699
- 21—Name the parts of a modern Delco distributor-timer (fig. 8), page.....377
- 22—Is the timer-distributor shaft driven at $\frac{1}{2}$ speed of crank shaft?.....377

23—Is distributor placed above the timer?.....377

24—What is meant by “automatic advance of spark”?.....249

25—How is this accomplished and where is the automatic governor located?.377, 249

26—Is there a slightly different arrangement of the governor action as used on
Delco-Cadillac timer-distributor?.....132

27—What occurs as the speed increases?.....249, 377, 132

28—Does this governor also automatically advance the distributor brush?.249, 377, 132

29—Can the time of spark be advanced, independent of the automatic advance?
.....377, 246, 249, 132

30—What part does the hand control move?.....377, 246, 249, 132

31—Why is hand control used at all, if spark can be automatically advanced and
retarded? 246, 249, 377, 307

32—What range of advance is it possible to get with a timer-distributor, and is
it more than with a magneto? (foot-note).....309

33—How many lobes or notches would there be in or on the timer shaft used, for
a six-cylinder engine?.....248

34—How many segments on distributor for a six-cylinder engine?.....248

35—How many for an eight-cylinder engine?.....132

35a—Would it be possible to use a regular magneto type of interrupter and cam
and revolve the timer and distributor at different speeds, in connection with a
coil and battery system of ignition?.....244

35b—If cam had but two projections, how many revolutions would it make and how
many revolutions would distributor brush make to two revolutions of crank
shaft on a six-cylinder engine?.....244

36—What distance is usually given the spark plug gap with a Delco system?....378

37—Where is ignition unit located on the system shown on page 376?.....376

38—How is the timer-distributor driven?.....376

39—What speed does pump shaft revolve?.....377, 376

40—Then, if timer-distributor shaft must revolve at half speed of crank shaft,
then the change could be made in the gear on timer-distributor shaft, fig. 8,
page 377, so that timer-distributor shaft would turn at half speed of crank
shaft, could it not? Yes.

41—Is the motor generator also driven, in this instance, by the pump shaft?.....377
(Note.—It is of course understood that the pump shaft drives the pump, not shown
in illustration, and this pump shaft could be driven by gears connected with crank-
shaft gear or camshaft.

42—Where is the Delco ignition coil located in this instance?.....378

43—Could it be located on the dash or elsewhere if necessary?.....376

44—Is it also called an ignition transformer coil, and is it a regular double wound
high tension coil without a vibrator?.....378

45—What is the primary winding of coil connected with? Is one end connected
with timer or interrupter terminal, and does the other contact on timer con-
nect with ignition resistance unit, thence to ground or frame, thence to nega-
tive (—) battery terminal?.....378, 376

46—Does other end of primary winding on coil connect with dry cells through
switch button B, and storage battery or generator, through switch button M?.376

47—Could current for primary circuit of ignition coil also be taken from generator
if speed was high enough? Yes.

48—In system shown on page 376, does one armature serve for both generator
and starting motor? (See foot-note, page 386).

49—When the timer contacts interrupt this primary circuit, what takes place?...378

- 50—What does one end of the secondary winding of this coil connect with?..378, 376
 51—What part of the distributor does the other end connect with?.....376, 378, 377
 52—From the center connection of distributor, where does the secondary current go? 378, 376, 377
 53—What is the object of a condenser? Where is it located, and for what purpose? 378
 54—What is the result if condenser is defective?.....378
 55—What is the ignition resistance unit for, and how made, and where located?..378
 56—What is meant by "impedence" of the coil?.....378

INSTRUCTION No. 28B.

Delco Electric Systems.

- 1—Does the Delco electric system employ one armature for the starting motor and generator?.....381
 2—How many commutators are there, and what is each for?.....381
 3—Where can the commutators be located?.....381
 4—Are there two windings on armature, and what for?.....381
 5—How many windings are there on the field, and what kind of field poles are employed? 381
 6—Name the two windings on the field poles.....381
 7—What method is employed to drive the Delco motor-generator on page 379?..379
 8—When starting motor is in operation how does the current flow?.....379
 9—Explain briefly the action of the one-way clutch.....379, 380
 10—How does the starting motor start the engine?.....379
 11—State briefly the procedure of starting engine with the system on page.....379
 12—What is the purpose of first using the generator as a motor?.....379
 13—Is the brush on "starting motor" commutator in action at this time?.....379
 14—After generator armature is revolving slowly, what is the next operation, and what takes place?.....379
 15—Is the motor generator brush disconnected as in fig. 2, page 379 and page 380, after engine is started, and starting lever placed in normal position again? 379, 380
 16—Are the generator brushes always on contact, and during the period of starting, does the armature turn free of shaft driving it, due to the one-way clutch, and after motor brush is raised, is the armature then driven by this clutch, and does generation of current begin?.....379, 380
 17—Name the different kinds of regulation methods employed on the different Delco systems.....381
 18—Which method is the one now most popular?.....381
 19—What is the object or purpose of regulating the output of the generator?..380, 381
 20—Name the parts of the "mercury" voltage regulator.....380
 21—Explain (briefly) the action of the "mercury" voltage regulator and how it regulates the output of generator and when.....380
 22—Name the parts of the "variable-resistance" regulator.....381, 384, 383
 23—What does this regulate and what for?.....381, 384, 383
 24—Explain (briefly) the action of the "variable resistance" method of regulating the output of generator and state what method and device is used to vary the amount of resistance "cut-in" and "out" of the field circuit of generator. 383, 381, 384
 25—Is this variable resistance mechanism incorporated in the ignition unit?..384, 383

26—What is the ignition resistance-unit (D, fig. 3, page 384) for?.....383, 246, 381

27—Is the timer cam or time of spark automatically advanced at the time the resistance is cut-in?.....383

28—For what purpose was the “cut-out” used on the early Delco electric system?.383

29—Is the “cut-out” eliminated on the later Delco systems?.....383

30—Explain (briefly) the principle now employed to take the place of the “cut-out” 383

31—Explain (briefly) the starting operation of the Hudson “six-40”.....385

32—Explain (briefly) the starting operation of the 1918 Hudson.....385

33—Was the variable resistance method (Delco electric system) used on the Hudson “six-40”?.....382

34—What kind of regulation (Delco electric system) was used on the 1918 or “super-six” Hudson car?.....391

35—Was the Delco “third brush regulation” used on the Delco motor-generator applied to the Buick D54 and D55?.....386

36—Where was motor generator and also the ignition apparatus located?.....386

37—What three distinct functions does the motor-generator perform?.....386

38—What is meant by “motoring the generator”?.....386

39—When does this operation take place?.....386

40—Why is the “motoring of generator” necessary?.....386

41—What is the cause of clicking sound heard during the time of “motoring generator”? 386

42—What is the purpose of the “generator-clutch”?.....386

43—How is this clutch lubricated, and how often?.....386

44—What is meant by “cranking operation”?.....386

45—Explain, briefly, what takes place when the cranking operation is performed 386

46—Should the cranking operation be for as brief a time as possible? Why?...387

47—Explain, briefly, the action of the ammeter during the cranking operation....387

48—What should be done the instant engine fires or starts?.....387

49—What is the “motor-clutch” for and where located?.....387

50—How is this clutch lubricated and how often?.....387

51—When the cranking operation is finished, and the starting pedal released, what action then takes place?.....387

52—State at what speeds the generator supplies charging current?.....387

53—What parts does the motor-generator consist of?.....387

54—Explain, briefly, the flow of current when cranking and generating.....387

55—How is “direct” current obtained?.....387

56—Explain the principle of the flow of ignition current.....389

57—What is meant by “third-brush” regulation?.....389

58—Explain, briefly, the principle of “third-brush” regulation.....389

59—At what speed is trouble experienced in keeping battery charged?.....390

60—When car is driven at high speed, does this cause generator to produce more current? 390

61—How can the output or amount of current of generator be decreased or increased? 390

62—Is it necessary to sandpaper the brush each time the position of it is changed? 390

63—State the highest ampere rate the generator should ever be set for.....390

64—Explain, briefly, the method of timing the Delco system on the Hudson.....390

- 65—What is meant by checking the ignition timing?.....390
- 66—How does the Delco system on page 393, differ from the one on page 392? 393, 392
- 67—On page 384, the armature has a commutator at each end; state what purpose each commutator serves 384
- 68—On page 395, where are the motor and generator commutators located?.....395
- 69—How does this Delco motor-generator differ from the one on page 384?...384, 395
- 70—How does the Delco system on page 396 differ from the one on page 388?.396, 388

INSTRUCTION No. 28C.

Care, Tests and Adjustments of Delco Electric Systems.

- 1—Name the five principal places to lubricate the Delco electric system, and how often 397
- 2—In the Delco system using “variable resistance” method of regulation, are the resistance spools individually suited for different generators?.....397
- 3—How would you test the output of generator?.....397
- 4—In the Delco system which used a “cut-out,” what must be kept in mind when adjusting? 398
- 5—How is the Delco generator clutch removed?.....398
- 6—How would you test for a defective condenser?.....398
- 7—How would you test for a defective coil?.....398
- 8—What is the result if there is a short-circuit in the secondary winding?.....398
- 9—How would you test the accuracy of an ammeter?.....398
- 10—Can a volt meter and an ammeter be combined in one instrument?.....398, 414
- 11—How many amperes and how many volts should the scale maximum readings provide for, on a good instrument?.....398, 414
- 12—Explain what the parts consist of and what parts move?.....398
- 13—Explain the principle of the ammeter shown at bottom of page 414 and state how it differs from the one on page 398.....414, 398
- 14—What is the purpose of an ammeter and how is it placed in the circuit?..415, 417
- 15—Does it show the quantity of current consumed by the starting motor?....415
- 16—Could you test a storage battery with an ammeter by placing the terminals directly across the battery?.....399
- 17—When does ammeter needle indicate that battery is being charged and discharged? 415, 417
- 18—What is the purpose of a volt-meter?.....414, 453, 399
- 19—Can a volt meter be connected directly across the battery terminals, as shown in diagram B, page 416?.....416
- 20—Could you also test the voltage of each cell, as shown in diagram A, by connecting voltmeter with terminals of each cell?.....416
- 21—Could you also test for an open circuit, per diagram I, or test a coil for a ground, per K, with a volt-meter?.....416
- 22—If you were to test with an ammeter by placing it across the terminals of a battery, it would damage ammeter, would it not?.....399
- 23—Then, for an ammeter to be used to indicate the ampere discharge, up to the capacity of the ammeter (say it is designed for 30 amperes) then it would be placed in “series” and would indicate the quantity of current passing in the wires, as in fig. 1, page 391, would it not?.....415
- 24—If you desired to test the ampere capacity of a battery higher than that of the capacity of the meter, is there a “shunt” used?.....414

- 25—What is a “shunt” for; what is it made of, and how connected with an ammeter? 414
- 25a--What is meant by a shunt winding?.....333, 335, 345
- The “shunt” used with an ammeter has no relation to the shunt winding, but this question is asked in order to distinguish the two. When an external shunt is used in connection with an ammeter (page 416), it will be noted that the connection is a “shunt connection,” or across the line.
- 26—How would you test the voltage of a storage battery?.....399, 453
- 27—Make a sketch showing how you would connect a volt-meter to test a single cell of a battery? 416
- 27a--Make a sketch showing how you would connect volt-meter to test all the cells of battery. 416
- 28—Make a sketch showing how you would test the voltage of a generator.....414
- 29—Make a sketch showing how you would test a generator with a volt-meter to see if coil in armature is open-circuited or short-circuited.....402
- 30—How would you test a dry cell with a volt-meter or ammeter?.....241
- 31—It would make no particular difference if you tested a dry cell with an ammeter if the amperage capacity of battery was below the range of the meter. Would it? 399
- 32—Make a sketch showing how you would test the adjustment of vibrator on a high tension or induction coil with a special low reading ammeter.....234
- 33—What are test points for?.....399
- 34—How would you make a set?.....399
- 35—Make a sketch showing how you would connect same to a circuit.....399
- 36—Is the lamp in series with the points and must the points touch to cause lamp to light? 399
- 37—What is meant by “counter-electro-motive-force”? 399
- 38—How does this affect the first reading of an ammeter?.....399
- 40—When “motoring” generator and ignition button is pulled out, what should ammeter indicate in amperes? 400
- 41—Suppose the armature did not revolve when “motoring” the generator, what would likely be the cause? 400
- 42—If ammeter vibrates at each revolution of armature during time of “motoring-generator,” with engine running at low speed, what is evident?.....400
- 43—How does the current flow and from what source when cranking the engine?.....400
- 44—Is the shunt field current necessary when performing this operation?.....400
- 45—How much average power is consumed when cranking?.....400
- 46—What are “cranking” or starting failures due to?.....400
- 47—When cranking, what voltage should the three-cell battery show if specific gravity registers 1,200 or more? 400
- 48—What is likely the trouble if starter, lights and horn all fail?.....401
- 49—What is likely the trouble if lights, horn and ignition are OK. but engine fails to start? 401
- 50—If starter fails to start, or starts slowly, and lights go out, or get very dim while starting, what is likely the trouble?.....401
- 51—If engine fires properly on “M” button but not on “B” button, what is likely the trouble? 401
- 52—If engine works OK. on “B” button, but not on “M” button, what is likely the trouble? 401
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- 51—Make a sketch showing how you would charge a single battery, using 32 c.p. lamps, to charge at 10 amperes.....460
- 52—Suppose you wished to reduce the charge to 5 amperes, how many 32 c.p. lamps would you use?.....460
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- 55—Make a sketch showing how you would charge 11 batteries at one time, using lamp resistance.....460
- 56—Why is it necessary to use more lamps when charging more batteries?....460
- 57—What rate of charge is best to charge several batteries at one time?.....460
- 58—Suppose some of the batteries are smaller and some are only partially discharged, and others fully discharged, how would you regulate the charge?..460
- 59—If you had an ammeter in the circuit during the charge, how is it connected, and what does it indicate?.....460
- 60—What instruments can there be used to test with, during the charge?.....460
- 61—How would you determine when battery is charged, with a volt-meter?.....460
- 62—How would you determine when a battery was charged, with a hydrometer?.460
- 63—Could you charge batteries from a 220 volt "direct current circuit," if so, would you use more lamps than on a 110 volt circuit?.....461, 460, 465
- 64—Why? 461, 460
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- 66—Why? 461, 465
- 67—What is a rheostat for, and how constructed?.....460, 474, 464, 463
- 68—Could water be used for resistance?.....463
- 69—What is a "resistance" unit?.....463, 464
- 70—What is a "resistance" unit made of?.....464
- 71—Is resistance referred to as "ohms"?.....464
- 71a—What is meant by an "ohm"?.....863, 207
- 72—Are these "resistance units" then measured in so many "ohms" capacity?..464
- 73—How many "ohms" resistance is there required for charging a 3 cell battery at a 3 ampere rate?.....464
- 74—How many ohms resistance is there required for charging two 3 cell batteries at a 3 ampere rate?.....464
- 75—Suppose you had two resistance units of full 15 ohms capacity each, giving a total of 30 ohms, are there "taps" or connections provided whereby only part or all of the resistance can be thrown into the circuit?.....464

- 76—When connection clamp is at A, fig. 11, is all the resistance in the circuit, and is there less current flowing through battery?.....464
- 77—When connection or clamp is at F, is there a less amount of resistance in the circuit, and is the charging rate greater?.....464
- 78—When connection is at J, how many ohms resistance is there in the circuit?.....464
- 79—As the resistance is cut out, the charging rate is higher. Is it not?.....464
- 80—The more batteries in series the less resistance to be used. Is this correct? Why? 464
- 81—How are batteries connected when there are more than one battery to charge? 464, 462
- 82—Is the positive pole of one battery connected to the negative pole of the next, and so on?.....464
- 83—Is the positive and negative terminal of battery connected with the positive and negative terminal of charging circuit?.....464
- 84—As the batteries become charged will the charging rate become less?.....464
- 85—If so, how would you increase the charge, when using resistance units?...464
- 86—How would you tell when battery was charged?.....464
- 87—If one battery becomes charged before the others do, what is necessary to do? 464, 460
- 88—Can a storage battery be charged from an alternating current circuit?.....463
- 89—What is a rectifier for?.....463
- 89a—What is a mercury arc rectifier for?.....463
- (Note.—The General Electric Co., Schenectady, N. Y. (Supply Dept.), now supply what is known as a "Tungar Rectifier.")
- 90—Could water and acid be used as a rectifier?.....463 466
- (Note.—The solution used in rectifier, fig. 22, page 466, is a concentrated solution of common baking powder and pure water.
- 91—When charging with a rectifier is it important to have positive terminal of battery connected with positive terminal of charging wire? Ans. Yes; on all types of rectifiers except one type of vibrator rectifier.
- 92—What is a motor-generator set for?.....462
- 93—What does it consist of?.....462
- 94—Suppose you had a 3 cell, 6 volt battery and the headlights were 6 volt, but tail light and dash light 3 volt; make a sketch showing how you would connect same 466
- 95—Suppose you had a 9 cell, 18 volt battery and you wished to obtain 6 volts at the battery terminals, how would you connect the cells?.....466
- 96—Would the ampere capacity of the combined cells be greater, if the 9 cells were connected for 6 volts, than if connected for 18 volts?.....466
- Read "Battery Connections" carefully on page 466.
- 97—With a Tungsten filament lamp, what amperage does a 6 c.p. lamp draw at 6 volts?.....467
- 98—With a Tungsten filament lamp, what c.p. is a lamp which consumes 1 ampere at 6 volts?.....467
- 99—With a Tungsten filament lamp, what c.p. is a lamp which consumes 5 amperes at 6 volts?.....467
- 100—With a Tungsten filament lamp, what c.p. is a lamp which consumes 7½ amperes at 6 volts?.....467
- Read page 443 and note what the numbers on a battery indicate.

Storage Battery Repairing.

- 101—What tools are generally used for storage battery work?.....463, 474, 473, 472
- 102—What are the most common battery troubles?.....463
- 103—Before disassembling a battery should the battery be tested to locate the defective cell?.....463
- 104—Should other cells, if not defective, be washed and new separators added?..463
- 105—State procedure for disassembling a battery?.....463, 469
- 107—How would you proceed to take the elements apart?.....469
- 108—How would you proceed to remove a bad plate?.....469
- 109—What examination should be given the positive plates?.....469
- 110—What examination should be given the negative plates?.....469
- 110a—What examination should be given the wood separators?.....469
- 111—What are separators made of, and how should wood separators be kept?..469
- 112—Is it advisable to wash out all sediment when a battery is apart?.....469
- 113—What should be done with the old electrolyte?.....469, 470
- 114—If an old battery case is to be used again, which is acid-soaked, what should be done with it?.....469, 473
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- 123—If battery was repaired for a short-circuit, what s.g. of electrolyte is used?.470
- 124—When putting in new separators and new electrolyte, if s.g. should drop, while charging, instead of rising, what is likely the cause?.....470
- 125—If storage battery is in a charged state and new solution or electrolyte is put into it, what is the result, and what s.g. solution should be used?.....470
- 126—How long after repairing a battery should the charge be started?.....470
- 127—At what rate should you charge a repaired battery, and for how long?.....470
- 128—Should temperature readings be taken?.....470
- 129—When the charge is complete, what should be done?.....471
- 130—What is meant by “adjusting gravity”?.....471
- 131—Suppose adjustment is considerable, what is necessary to do?.....471
- 132—After adjustment, what should be done?.....471
- 133—If the temperature is far from normal, what should be done?.....471
- 134—Should top and sides of battery be wiped? What with?.....471
- 135—What is meant by “lead burning”?.....471
- 135a—What is the difference between a “burned connector” and a “bolted” connector? 468
- 135b—What parts of a battery require “lead burning”?.....445, 470, 471
- 136—Can a gas outfit be used for “burning” lead connectors?.....471, 472
- 137—What kind of gas is used, and which is best?.....471, 472
- 138—Name the parts of a gas “burning outfit”.....471, 472
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148—How would you proceed to remove a cell from a Willard battery?.....473

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151—How would you make a battery box acid proof?.....473

152—Suppose electrolyte has been spilled from a cell, what would you do in replacing it?.....473

153—What is compound for sealing jars made of?.....474

154—In what sort of receptacle should electrolyte be kept?.....474

154a—What is meant by a “Cadmium test” of a storage battery? Ans. By means of a stick of cadmium inserted into the electrolyte, the positive and negative plates of each cell can be tested, in order to find out if one or more plates are defective.

155—What are the plates in an Edison storage battery cell made of?.....475

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INSTRUCTION No. 33.

The Electric Vehicle and Other Electrical Devices.

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2—What is the disadvantage of an electric vehicle?.....477

3—What are the main parts of an electric vehicle?.....477

4—How many cells are generally used?.....477

5—Is the consumption of current greater when first starting from a standstill?.....477

6—What is the mileage of an electric vehicle dependent upon?.....477

7—What is the function of the controller?.....477, 478

8—How is the speed of motor varied?.....477, 478

9—Describe, briefly, the principle of the Woods Gas-Electric car.....479

10—Describe, briefly, the principle of the Electric brake.....479

11—Describe, briefly, the principle of the Prest-O-Vacuum brake.....479

12—Explain, briefly, the principle of the Entze electric transmission.....480

13—Is there any mechanical connection between engine and drive shaft?...480, 481

14—Is a clutch used?.....480, 481

15—What takes the place of the clutch? 480, 481

16—What takes the place of the transmission? 480, 481

17—How does the engine drive the rear axle?.....480, 481

(Note.—Study the control lever positions, page 481. See also questions 42 to 51, under Instruction No. 6.)

18—Explain, briefly, what the magnetic gear shift is for.....482

19—How are the gears of transmission shifted?.....482

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20—What was the “magnetic latch” on 1914 model Cadillac used for?.....483

21—Where was the magnetic latch placed?.....483

22—Briefly state operation of it when engine was started by starting motor....483

23—Briefly state for what purpose the two drive pinions on drive shaft, and two driven gears on differential were for, on the Cadillac (1914) "two-speed" rear axle 483

24—Was this in addition to the transmission?.....483

25—Briefly state how the speed change on rear axle was made, and what the magnetic latch was used for in connection with it.....483

26—How is the Gas-Electric truck driven, as shown on page 484?.....484

27—Where is the gasoline engine placed, and what is it used for?.....484

28—Where are the electric motors placed, and what are they used for?.....484

29—Where is the electric generator placed, how driven, and for what purpose is it used? 484

30—How are the four wheels steered?.....484

31—What is the function of the "evener device"?.....484

INSTRUCTION No. 34.
Operating a Car.

1—What are the first things to become familiar with before attempting to operate a car?.....485

2—State a simple method for doing this.....485

3—What is the "gear shift lever" used for on a selective type transmission, and state the kinds in general use.....485, 49

4—What is the purpose of a clutch?.....37, 493

5—What is the purpose of the transmission?.....45

6—What is meant by "neutral" position of gear?.....46

(Note.—Review questions under Inst. 6. It is not necessary to answer same.)

7—Name the different types of lever systems which have been used, and those that are now used.....485

8—Name the usual foot pedals.....485

9—Is the clutch pedal always the left one, and the brake pedal the right one?.29, 39

10—Where is the spark lever usually placed?.....485

11—Where is the throttle lever usually placed?.....485

12—What is the function of the accelerator?.....492

13—Is the throttle lever usually longer than the spark lever?.....485

14—Before starting an engine or car, what is the first precaution?.....487, 493

15—Where would you place gear lever or gears, before starting engine?....487, 493

16—State, briefly, exact procedure in starting engine, just what you would do first, then next, and so on, until engine was running.....487, 493

17—After engine had started what would you do?.....487, 494

18—Before attempting to place car in motion, what would you do?.....487

19—How would you then start car?.....486

20—Should starting of car be done on low gear?.....486, 493, 494

21—State, briefly, how you would put gears in first, or low speed from "neutral"..486

22—State, briefly, how you would change from "low speed" to "second speed," and then from "second" to "high or third" speed.....486

23—Is most of the running done on high gear?.....486

24—What does "high gear" mean?.....486

25—How would you set spark for starting?.....486, 67, 68

26—How would you set spark after starting?.....486, 67, 68

27—Do you advance spark as engine is speeded up?.....486, 67, 68

28—How would you stop car?.....489, 495

29—How would you reverse car? And what is first necessary to do?.....486, 488

30—Could engine run if car is not running?.....489

31—What would be necessary to do to prevent car from running?.....489

32—How would you slow your engine down when car was not running?.....489

33—How would you stop engine?.....489

34—Is it a good idea to draw gas into cylinders just before stopping?.....489

35—How and why would you do this?.....489

36—What is necessary to do before “running in” or “breaking in” a new car?.489, 491

37—What is liable to happen if a new engine is run too fast?.....203

38—Is it advisable to “race” engine, after having been left standing over night?
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39—What is meant by gear shift movements?.....490

40—What is the difference between the “gate” type and “ball and socket” type?.490

41—What is meant by the “S.A.E. standard” gear shift movement?.....490

42—Is this the movement which is used most?.....490

43—What does S.A.E. mean?.....534

44—Make a sketch of the S.A.E. 3 speed gear shift movement. Which is used,
most? 490

45—Make a sketch of the S.A.E. 4 speed gear shift movement.....490
(Read the following pages carefully, 491, 492, 493, 494, 495.)

46—What is the best method of applying the brakes to stop a car, and why?..494, 495

47—Which brake on a car is used most, the foot or the hand brake?.....691

48—When should a change be made from high to low gear?.....494

49—What is meant by a car “skidding”?.....506, 495

50—Does the rear end usually skid first?.....495

51—What causes a car to “skid”?.....495, 506

52—What is the best method to overcome “skidding”?.....551, 588, 495

53—Are chains provided on the rear tires to prevent skidding?.....551
(Study pages 496, 497, 498, 499 and 500 carefully.)

54—From foregoing information, and information on the pages mentioned here,
briefly state just how you would start the engine on an Overland car.497, 358, 254

55—What gear shift movement (on page 490) does Overland gear shift movement
correspond with, and what type of gear shift lever is used?.....49

INSTRUCTION No. 35.

Rules of the Road.

1—What side of the road should you drive on?.....501, 502

2—Should slow-moving vehicles remain closer to the curb or on the right side of
the road?.....501, 502

3—Should fast-going vehicles take more of the center of the road?.....501, 502

4—In passing a vehicle, should you pass on its left?.....501, 502, 504

5—In stopping or slowing down, should you be on the extreme right side of the
road? 501, 502

6—When turning a corner, what side should you turn on?.....502
(Read and study illustrations on pages 502-504, carefully.)

7—When two vehicles approach a street intersection simultaneously, as per lower
illustration, page 502, which one has the right of way?.....502

8—What is the minimum distance from a fire plug allowed by law, when parking
your car on a street?.....503

9—Is it against the law (in most states) to have glaring headlights?.....504, 433

INSTRUCTION No. 36.
Care for a Car.

1—If a tire “blows out,” should the brakes be applied suddenly?.....506

2—What happens to tires that are not sufficiently inflated?.....506

3—When applying new tires, is it a good plan to put them on the rear wheels and
remove those on the rear to the front wheels, if tires are all the same size?..506

4—In case of a gasoline fire, what is the best method to put it out?.....506, 507

5—After an engine has run a great number of miles, what is likely to happen?
.....506, 507

6—Should all nuts and bolts be gone over and tightened periodically?.....507

7—State procedure of washing a car?.....507

8—Is it injurious to the varnish to rub mud off a car?.....507

9—When washing car, what should be used?.....507

10—After washing car, what should be used to dry it with?.....507

11—Should the chamois be washed out and all of the water squeezed or wrung out
of it when wiping off the car?.....507

12—How would you clean mud from a radiator?.....507

13—Should a car be washed immediately after it is rained upon?.....507

14—Is body polish a good thing to use to polish car after it is washed and dried?..507

15—Should the surface be rubbed dry after using body polish, in order that it does
not collect dust?.....508

16—Is it injurious to the varnish of a car to wipe the dust off? Yes. It will
cause the dust to scratch the varnish. Dust off first with a soft wool duster.
(Read pages 507, 508, 509, and 510 carefully.)

INSTRUCTION No. 37.
Accessories.

1—What is the purpose of a speedometer?.....511

2—What is the purpose of an odometer?.....511

3—How are speedometers and odometers usually driven?.....513

4—What is the “trip register” for on an odometer?.....511, 512

5—What are the indications of trouble of a speedometer?.....512, 742

6—What is a bumper for?.....511, 514

7—Name the necessary accessories.....511

8—Name the desirable accessories.....515

8a—Name the types of electric horns.....515, 514

9—What is the principle of the “electric vibrating” horn?.....515, 514

10—What is the principle of the “electric motor” horn?.....515, 514

11—State, briefly, how you would adjust the Klaxon horn?.....514

12—What is the difference between the “compression whistle” and the “exhaust
whistle”? 515, 514

(Read pages 515, 517, 518, 519, 520, if you ever start on a tour.)

INSTRUCTION No. 38.
Insurance, License and Laws.

- 1—What is the difference between fire and theft, liability, property damage and collision insurance?.....521
- 2—Name the two kinds of licenses issued by states and cities.....522
- 3—What is the usual age limit?.....522
- 4—How would you proceed to obtain a chauffeur's license?.....522
(Read pages 524, 525, 526, 527.)
- 5—State, briefly, the things to be considered before purchasing a second-hand car? 528
- 6—State, briefly, some of the important points to consider before purchasing a commercial car.....528

INSTRUCTION No. 39.
The Automobile Salesman.

- 1—What is necessary to become a successful automobile salesman?.....529
Read carefully, "Salesmanship Pointers," pages 529, 530, 531, 533.

Read carefully and ask yourself the following questions (you are not required to write the answers):

- 1—What are the advantages of the long stroke engine?.....531
- 2—What are the advantages of the short stroke engine?.....531
- 3—What are the advantages of a five-bearing crankshaft?.....531, 532
- 4—What are the advantages of a three-bearing crankshaft?.....532
- 4a—What are the disadvantages of a five-bearing crankshaft?.....532
- 5—What are the advantages of the "offset" cylinders?.....532
- 6—What are the advantages of the eight-cylinder engine?.....532
- 7—What are the advantages of the six-cylinder engine?.....532
- 8—What are the advantages of the four-cylinder engine?.....532
- 9—What are the disadvantages of the eight-cylinder engine?.....532
- 10—What are the advantages of the T-head engine?.....532
- 11—What are the disadvantages of the T-head engine?.....532
- 12—What are the advantages of the over-head valve engine?.....532
- 13—What are the advantages of dual valves?.....927
- 14—What are the advantages of a balanced crankshaft?.....532
- 14a—What are the advantages of a full-floating axle?.....532
- 15—What are the advantages of a three-point suspension?.....533

INSTRUCTION No. 40.
Horsepower, Table and General Data.

- 1—Explain the meaning of horsepower 535
- 2—Explain the meaning of "brake" horsepower.....535
- 2a—Explain the meaning of "actual" horsepower.....535
- 3—Explain the meaning of "indicated" horsepower.....535
- 4—Explain the meaning of "total power" of an engine.....535
- 5—What do the initials H.P. (as here used) stand for?.....535
- 6—What do the initials B.H.P. (as here used) stand for?.....535
- 7—What do the initials I.H.P. (as here used) stand for?.....535
- 8—What is the h.p. of an engine dependent upon?.....534
- 9—What is meant by piston speed of an engine?.....534
- 10—What piston speed was the S.A.E. horsepower formula worked out from?....534
- 11—What does the factor of piston speed take in?.....534
- 12—Suppose the stroke of an engine was 4 inches, how many strokes would the piston make to travel 12 inches or one foot?.....534
- 13—How many strokes would piston make, to travel 1 foot, if engine was a 6-inch stroke? 534

- 14—How many feet would a piston travel in an engine with a 3-inch stroke when crank shaft was turning 200 revolutions per minute?.....540
- 15—State how the S.A.E. formula estimates the h.p. of an engine.....534
- 16—Figure out the h.p. (S.A.E. formula) of a four-cylinder engine with a 4-inch stroke 534
- 17—What does D2 mean?.....534
- 18—What does N mean?.....534
- 19—Is the stroke of engine considered at all in the S.A.E. formula?.....534
- 20—What is meant by the “constant”?.....534
- 21—Does a gasoline engine depend upon speed for its power? Why?.....536
- 22—Why are transmission gears necessary in use with a gasoline engine for automobile work?.....536
- 23—Is the maximum h.p. greater than the nominal h.p.?.....536
- 24—What is a fan dynamometer for?.....536
- 25—What is an electrical dynamometer for?.....536
- 26—Is the amount of work the dynamo will do, such as lighting lamps, etc., dependent upon the power put into it by the engine, and, is the h.p. calculated in this way?.....536
- 27—What is meant by a “prony” brake h.p. test”?.....537
- 28—What is a taximeter for?.....537
- 29—What is the meaning of “piston displacement”?.....538
- 30—What is the “piston displacement” of a four-cylinder engine, 4-inch bore, and 5½-inch stroke?.....538
- 31—How are “grades” expressed?.....539
- 32—Make a sketch showing the “incline” or “angle” of a line to represent a 100 per cent grade.....539
- 33—What “angle” would a “100 per cent grade” represent, from the horizontal line A to B? 539
(Study the other subjects on page 539.)
- 34—What is meant by a “degree,” and what is the designation or symbol of a degree? 541, 93
- 35—What is a “protractor”?.....541
- 36—Express in figures, “one-thousandth of an inch”.....541
- 37—What would the following figures mean: .015?.....541
- 38—What would the following figures mean: .030?.....541
- 39—What part of an inch would .125 be, expressed in a common fraction?.....541
- 40—What is meant by “metric system”?.....541
- 41—What is the sign or symbol of “inches”?.....541
- 42—What is the sign or symbol of “seconds”?.....541
- 43—What is the sign or symbol of “feet”?.....541
- 44—What is the sign or symbol of “minutes”?.....541
- 45—What is the sign or symbol of “millimeters”?.....541
- 46—What is a “millimeter”?.....541
- 47—What part of an inch are 20 mm.?.....541
- 48—How many cylinders has the Ford engine?.....544
- 49—What is the “bore” and “stroke” of a Ford engine?.....544
- 50—What is the horsepower of a Ford engine?.....544
- 51—What is the “piston displacement” in cubic inches?.....544
- 52—What is the “high gear ratio”?.....544

53—What is the make of engine?.....544

54—What “type of cylinder” is used?.....544

(These questions are asked in order to familiarize the student with the method of determining the specifications of leading cars. The balance of the specifications can be followed out by the student.)

(See pages 547, 548, where to obtain parts for Orphan Cars, or cars no longer manufactured. Some day, when you are repairing cars of old makes, this may be of value to you.)

INSTRUCTION No. 41.

Tires.

1—Why are rubber tires used on automobiles?.....549

2—Name two types of tires.....549

3—Why are “solid tires” not suitable for high speed cars?.....549

4—What kind of a tire is a “pneumatic tire”?.....549

5—Name the two forms of pneumatic tires.....549

6—Of how many parts does the modern pneumatic tire consist?.....549

7—How is the tire held to wheel?.....549

8—What is meant by a “single tube” pneumatic tire?.....549

9—What is meant by “double tube” pneumatic tire?.....549

10—What are “bolts” or “lugs” used for?.....549

11—What part of a pneumatic tire is the “shoe” or “outer casing”?.....549

12—What type of inner tube is used on “double tube” pneumatic tires?.....549

13—What part of the inner tube is the “valve stem”?.....549

14—What is the “valve stem” for?.....549

15—What part is the “valve-stem-seat”?.....549

16—What part is the “inner valve”? 549

17—What is the “inner valve” for?.....549

17a—Describe a Schrader valve.....550

18—State, briefly, how you would proceed to inflate a tube in a pneumatic tire....549

19—State, briefly, how you would deflate tube.....551

20—State some of the causes of “slow air leaks”?.....551

21—How would you test for “inner-valve leaks”?.....551

22—How would you test for a “valve stem,” or “slow leak,” or “puncture”?.....551

23—What is the average life of a tube?.....551

24—What part of an outer casing (shoe) is the tread?.....549, 551

25—What part of an outer casing (shoe) is the bead?.....549, 553

26—State the two kinds of “treads” on outer casings.....551

27—What is the purpose of a “non-skid” tread tire?.....551

28—What other method is used to prevent “skidding”?.....551

29—Is the chain considered the best prevention for skidding?.....551

29a—How are weed chains applied?.....550

30—What are “rims” for, and to what part of the wheel are they fitted?.....549, 551

31—Name the two classes in general use?.....551

32—Name the different “clincher” type rims?.....551

33—What is the difference between the “plain clincher” rim and the “quick detachable clincher” rim?.....551

34—What is the difference between the “quick detachable clincher” rim and the “quick detachable, demountable clincher” rim.....551

35—Could the “straight side rim” be “quick detachable”?.....552

35a—Could the straight side rim be a “quick detachable, demountable rim”?.....553

- 35b—What is meant by a “reversible rim”? (foot-note).....553, 552, 551
- 36—When removing a tire with a “plain clincher bead,” from a “plain clincher rim,” is the rim removed?.....558, 551
- 37—Is it necessary to remove tire to take out a defective tube and put in another?
.....558, 551
- 38—When removing a “clincher bead” or “straight side bead” tire from a “quick detachable rim,” is the entire rim removed? If not, what part?.....551
- 39—Is it necessary to remove tire from rim to repair tube?.....551
- 40—When removing a “quick detachable, demountable” tire from a wheel, is the rim removed with tire?.....551
- 41—Is another tire mounted on rim already inflated, then put in place of the tire and rim removed?.....551
- 42—How does a “side ring” type rim differ from a “split rim” of the Q.D. demountable type?.....556, 557
- 43—State, briefly, how you would proceed to remove a tire from the rim of a “side ring” type 556
- 44—State, briefly, how you would proceed to replace a tire on the rim of a “side ring type.....556
- 45—State, briefly, how you would proceed to remove a tire from the rim of a “split ring” type.....557
- 46—State, briefly, how you would proceed to replace a tire on the rim of a “split ring” type.....557
- 47—How does the “cord” tire differ from the regular “fabric” type tire?.....559
- 48—State four ways of keeping down tire expense.....553
- 49—What causes more than three-fourths of all tire troubles?.....553
- 50—What governs the “inflation pressure” of a tire?.....553
- 51—Does an “under inflated” tire ride easier than a “fully inflated” tire?.....553
- 52—Is “under inflation” injurious to a tire?.....553
- 53—Name the different methods for “inflating” tires.....553, 562
- 54—How are “power air compressors” driven?.....553, 562
- 55—Explain the principle of the “impulse tire pump”.....562
- 56—Explain the principle of the “power driven air compressor”.....562
- 57—Describe, briefly, a “compound air pump”.....562
- 57a—For what different purposes can air compressors be used in garages?....563, 564
(Note how to determine size pulleys and speed to drive air compressors, page 563.)
(Note size tanks to use for inflating certain number of tires, page 564.)
- 58—On what 2 types of vehicles are solid tires generally used?.....560
- 59—Why are solid tires not suitable for pleasure cars?.....549
- 60—What kind of a solid tire is a “cushion” tire?.....560
- 61—What kind of a solid tire is a “dual” tire?.....560
(Note the different methods for attaching “grip” chains to solid tires on page 560.)
- 62—What kind of tires are there used on heavy trucks and some tractors?.....561
- 63—What kind of wheels are there used on tractors?.....829, 826
- 64—What tools are necessary to remove clincher tires?.....558
- 65—What tools are necessary to remove Q.D. and Q.D. demountable tires?..556, 557

INSTRUCTION No. 42.

Tire Repairing.

- 1—How is a “pneumatic tire” made?.....565
- 2—What part of tire holds the strain and pressure?.....565, 566
- 3—Is the rubber merely a cushion and a protection for the canvas?.....565
- 4—What is the best material for the “carcass” of a “fabric” tire?.....566
(Note the “cord” tire is considered the best carcass and others are called “fabric” carcasses.)
- 5—Is it injurious to a tire to run it flat, even for a short distance?.....565
- 6—Is oil and grease injurious to a tire?.....565
- 7—What is meant by “alignment of wheels”?.....565, 683
- 8—What is the result, if wheels are “out of alignment”?.....683
- 9—What is meant by “camber” of front wheels?.....683
- 10—What is meant by “toe-in” of front wheels?.....683
- 11—When a tire has a worn place around the center of the tread, what is usually the cause?.....683
- 12—Why does a right rear tire wear faster than the others?.....683
(Note.—See page 683 and 682 and study carefully.)
- 13—Name some of the troubles a tire is heir to.....566
- 14—How can small cuts on the tread be repaired?.....566
- 15—How can a “sand blister” be remedied?.....566
- 16—What is meant by “retreading” a tire?.....566
- 17—What is meant by a “rim cut”?.....566
- 18—What is meant by a “blow out”?.....566
- 19—Name the two classes of “blow-outs”.....567
- 20—What is the usual cause for a “rim blow-out”?.....567
- 21—What is the usual cause for a “tread blow-out”?.....567
- 22—How would you prevent a “rim blow-out”?.....567
- 23—How would you prevent a “tread blow-out”?.....567
- 23a—What is a “loose tread”? “worn tread”?.....566
- 24—How would you protect “weak places” in tires?.....567
- 25—What is meant by a tube “pinching”?.....567
- 26—How would you test an inner tube for a leak?.....567, 568
- 27—How would you test an “inner valve” for a slow leak?.....551, 568
- 28—How would you test a “valve-stem” for a leak?.....551, 568
- 29—How would you remove an “inner valve”?.....568, 551
- 30—Is it possible for a slow leak to come from an “inner-valve” being screwed down too tight? (foot-note).....551
- 31—If you get a puncture, is it important to see if nail or tack, or whatever caused the puncture, is not left in the tire case to puncture tube again?.....567, 558
- 32—Is it best to always put in spare tube and not try and repair tube on the road, but vulcanize it later?.....569
- 33—Is the modern method, to carry an extra tire inflated complete on a demountable rim ready to apply? Yes.
- 34—In this instance, would it be necessary that wheel be fitted for a demountable rim? Yes.
(Note page 569 how to cement a patch on an inner tube, also other pointers stated on page 569.)
- 35—What is the average “life of an inner tube,” and in what condition does it become as it grows old?.....569

- 36—What is meant by “lubrication of a tube”?.....569
- 37—Is there a liability of soapstone forming in lumps and injuring the tube, if too much is used and not evenly spread inside of tire case?.....569
- 38—What are “valve spreaders” used for?.....571
- 39—When inserting an inner tube in a tire, is it best to slightly inflate it?.....558
- 40—State, briefly, how you would proceed to remove an inner tube.....558
- 41—State, briefly, how you would proceed to replace an inner tube.....558
- 42—What is meant by “vulcanizing”?.....571
- 43—In repairing an inner tube puncture with an electric vulcanizer, what is first necessary to do?.....572
- 44—If hole is small, what is the procedure?.....572
- 45—Are edges then beveled?.....572
- 46—How long should repairs of this kind be vulcanized?.....572
- 47—If inner tube is cut or torn, what is the first thing to do?.....572
- 48—What is the next thing to do?.....572
- 49—How long is this vulcanized?.....572
- 50—When mending large bursts or blow-outs of inner tubes, what is the procedure?.....572
- 51—State, briefly, how you would proceed to “splice” an inner tube.....572
- 52—State, briefly, how you would proceed to repair a “valve-stem-seat”?.....572
- 53—What governs the time required for vulcanizing an inner tube?.....573
- 54—What steam pressure is generally used for steam vulcanizing?.....573
- 55—How would you test a vulcanized tube after repairing?.....573
- 56—How would you proceed to repair a “blow-out” in a tire case? State what would be the first thing to do.....575
- 57—How many coats of cement would you apply after scraping and cleaning?....575
- 58—How large would you cut the “first layer of fabric” for repair, and what kind of fabric would you use?.....575
- 59—How large would you cut the “second layer of fabric,” and would it be coated on both sides with para?.....575
- 60—Would you use a third and “fourth layer of fabric,” and what kind, and where would you place it?.....575
- 61—What would you do next with the tire?.....575
- 62—Where would you then sprinkle soapstone?.....575
- 62a—Is waxed paper then placed over the repair? What would you do next?....575
- 63—State, briefly, how you would then proceed to vulcanize, and for how long..575
- 64—Suppose the “blow-out” was close to the rim, how would the repair differ?..575

INSTRUCTION No. 43.

Digest of Troubles.

- 1—What does “diagnosing” automobile troubles require?.....576
- 2—Should you first “think” and try to reason out the cause of a trouble before starting to try and remedy same?.....576
(In other words, you should first “think,” then “act,” and not act before thinking. Remember this, it will save a lot of time.)
- 3—What are the two essentials necessary before an engine will run?.....576
- 4—To what are most troubles due?.....576
(Note.—Read page 576 carefully before proceeding further.)
- 5—What is meant by “process of elimination”?.....577
- 6—Do you clearly understand the meaning of the six lines at top of page 577?

7—Have you carefully read page 577?

8—Name three kinds of ordinary engine troubles.....578

(Note.—Ask yourself the following questions and answer same from memory after reading page 578 and 579. You are not required to send the answers in unless you so desire. This is a matter of reference.)

9—Briefly state cause if engine “fails to start”.....578

10—Briefly state cause if engine “starts, but misses”.....578

11—Briefly state cause if engine starts, but “pops in carburetor”.....578

12—Briefly state cause if engine starts, but “will not pull”.....578

13—Briefly state cause if engine “runs regularly for a few minutes and then stops.578

14—Briefly state cause if “engine stops suddenly”.....578

15—Briefly state cause if “engine stops slowly with missing”.....578

16—Briefly state cause if “engine loads up”.....578

17—Briefly state cause if “engine lacks flexibility”.....578

18—Briefly state cause if “engine misses explosion”.....579

19—Briefly state cause if “engine misses on high speed”.....579

20—Briefly state cause if “engine misses on low speed”.....579

21—Briefly state cause if “engine misses at all speeds”.....579

22—Briefly state cause if “engine does not deliver full power”.....579

23—Briefly state cause if “engine overheats”.....579

24—When an engine overheats by steaming, if the radiator is cold at the bottom and hot at the top, what is likely the trouble? (foot-note).....579

25—If radiator is warm at the bottom, is it likely to be frozen?.....579

26—Briefly state cause “if engine knocks”.....580

27—Briefly state cause “if engine will not stop when switched off”.....580

28—Briefly state cause if “engine runs well, but car drags”.....580

29—Briefly state cause if “the clutch drags”.....580

30—Briefly state cause if “the clutch grabs or is fierce”.....580

31—Briefly state cause if “the clutch leather (cone type) is oily”.....580

32—Briefly state cause if “engine back-fires in muffler”.....580

33—Briefly state cause if “crank case becomes very hot and engine weak”.....580

34—Briefly state cause if “exhaust pipe and muffler overheats”.....580

35—Briefly state cause if “engine makes a hissing noise”.....580

36—Briefly state cause if “gasoline fails to reach carburetor”.....580

37—Briefly state cause if “smoke continually comes from muffler”.....580

38—Briefly state the effect if there is a “crack in cylinder”.....580

39—Briefly state cause if “carburetor drips”.....580

40—Briefly state cause of “abnormal noise from transmission gears”.....580

41—Briefly state cause if “lubrication stops”.....581

42—Briefly state cause if “oil gauge does not show flow of oil”.....581

43—Briefly state cause of “oil leakage from engine”.....581

(Note the freezing point, boiling point and specific gravity of water, kerosene, alcohol and gasoline, page 585.)

(Read pages 581 to 590 carefully.)

INSTRUCTION No. 44.
The Automobile Repairman.

1—What class of work is the automobile repairman called upon to do most?....593

2—Is the trade of a machinist and that of an automobile repairman two distinct trades? 593

- 3—What is meant by “order and system,” in doing work around an automobile?.593
- 4—What kind of an automobile repairman would we class the “auto mechanician”?
.....594
- 5—What are some of the jobs most anyone can do after completing this course?.594
- 6—What is meant by giving a car a “general overhaul”? Does it include all
parts? 594, 595
(Read carefully, on pages 594 and 595, what is necessary to do to clean engine, lubri-
cate engine, clean car, lubricate car, inspection and adjustment, inspection of engine
and parts, engine adjusting.)
- 7—Is there a good profit in selling supplies?.....595
(Read page 595 carefully.)
- 8—How would you start as an “automobile mechanician,” and what is the best
plan to begin the trade?.....594, 597
- 9—Is it advisable to secure catalogues, instruction books, etc., of the different
manufacturers of cars, carburetors, electric systems, etc? Yes.
- 10—How would you find the address? See index, under “addresses.”

INSTRUCTION No. 45.
Equipping Garage and Shop.

- 1—What is the difference between a “repair shop” and a “garage”?.....597
- 2—Then it would be a question of first deciding if you wished to do repair work
or operate a garage and do repair work also.....597
- 3—State the different departments you could add to a garage.....597, 601, 610
- 4—State the different departments you could add to a repair shop.....597, 601, 610
(Read pages 596, 597, 598, carefully.)
- 5—What method is used most for heating a garage?.....598, 599
- 6—Name some of the “fixtures” required for a garage.....599, 601
- 7—How should the “gasoline supply” be stored?.....599, 602
- 8—What is a curb or roadside gasoline pump for?.....602
- 9—Is it important that a stock room be provided?.....601
- 10—Name some of the supplies in the rubber line which are always needed.....601
- 11—Is it profitable to handle lubricating oils and greases and sell to your cus-
tomers? 601
- 12—Name other departments which can be added, which are profitable.....601
- 13—Do batteries require charging more often in the winter? Why?.....601
- 14—What is an “inspection pit” for?.....601, 604
- 15—What is a “chain hoist” for?.....601, 604
(Read pages 607, 608, 609, carefully, and note supplies which are always needed
around a garage.)
- 16—What is meant by an “oversize piston,” and when is it required?.....609, 653
- 16a—What are the standard for oversize pistons?.....653, 654
- 17—What is meant by an “oversize piston ring,” and when is it required?.....609
- 18—What is meant by an “oversize valve-stem,” and when is it required?..609, 630
- 19—Name the different kinds of “open end wrenches”.....611
- 20—Where are open end wrenches used?.....611
- 21—What two classes are open end wrenches divided under?.....611
- 22—What is the difference between the “U.S.S.” and “S.A.E.” wrenches?.....611
(Note.—Study this page 611 carefully and note how to find the size wrench to fit a
standard cap screw or bolt and nut. It will first be necessary that you learn the
difference between a “cap screw” and a “bolt,” which is explained on page 701.)

(Read page 612 carefully and note the difference between the "S. A. E. cap screw and bolt sizes" and the "U. S. S. bolt sizes"; head and nut. Note the difference in the number of "threads" to the inch. Threads are explained on page 702.

- 23—What is a "spark plug shell"?.....612
- 24—Give the number of "threads to the inch," and "size of threads" used on S.A.E. spark plugs.....612
- 25—What is the diameter of the "small hexagon" of the S.A.E. spark plug shell?.....612
- 26—What is the diameter of the "large hexagon" of the S.A.E. spark plug shell?.....612
- 27—What are "screw dies" and "taps" used for?.....612, 704
- 28—What are "socket wrenches" used for, and how do they differ from an open end wrench?.....613
(Read pages 614, 615, 616, 617 carefully.)
- 29—What are "cylinder reamers" for?.....616, 653
- 30—What are "reboring machines" for?.....616, 653
- 31—What is the difference between "reaming a cylinder" and "reboring a cylinder"?
.....616, 653
(See questions 240a to 251, under Inst. 46.)
- 32—Name some of the machine shop equipment desirable for a small shop?.....618
- 33—What proportions of sand, gravel and cement are used, when mixing concrete, suitable for foundation and floor of garage?.....619

INSTRUCTION No. 46.
Repairing and Adjusting.

- 1—What does an "overhaul of a car" consist of?.....620
- 2—How would you proceed to "clean a radiator"?.....620
- 3—What attention should be given to carburetor?.....620
- 4—What attention should be given to clutch?.....620
- 5—What attention should be given to universal joint?.....620
- 6—What attention should be given to transmission?.....620
- 7—What attention should be given to wheels?.....621
- 8—What attention should be given to rear axle?.....621
- 9—Briefly state how you would proceed to "clean an engine".....621
- 10—What would you do after cleaning engine?.....621
- 11—Briefly state what attention you would give to the "exhaust system".....622
- 12—Briefly state how you would "grease a car"?.....622
- 13—Briefly state how you would "lubricate the springs".....622
- 14—What is meant by "oil film," and how does the proper film protect the engine? 623
- 15—What kind of oil should be used?.....603

Carbon.

- 16—What is meant by "carbon deposit"?.....202, 623
- 16a—What causes carbon deposit?.....623, 202
- 17—Will either too much gasoline fed to cylinders by carburetor, or too much oil and poor grade of oil, cause carbon deposit?.....623
(See page 202, "smoky exhaust—cause of," and read carefully.)
- 18—What are some of the causes of carbon deposit from the use of lubricating oil? 623

19—When a charge of gasoline and air is taken into the cylinder, what does it consist of?.....623

20—Is it the “oxygen” in the air combined with the “carbon and hydrogen of the gasoline,” that produces an explosive mixture?.....623

21—If the amount of air entering the carburetor is not sufficient to insure complete combustion, what is the result?.....623

22—How does this principle compare with that of a lamp wick?.....623

23—Where does carbon lodge or collect?.....623

24—Briefly state the bad effects of carbon deposit?.....625

25—Briefly state the “indications of carbon deposit”.....625

26—Name the different methods of “removing carbon” from cylinders.....625

27—Where should piston be placed when using oxygen for carbon removal?.625, 626

Compression.

28—State the main causes why an engine fails to develop its usual power?.....626

29—What is meant by “compression”?.....862

30—What is the ratio between the “compression pressure” and the “explosive pressure”? (foot-note).....626

31—Where is the “compression space” on an engine?.....627

32—Where could “compression leaks” occur on an engine?.....627, 628

33—What is the most frequent cause of “loss of compression”?.....628

34—Could a “loss of compression” be caused by leaky piston rings?.....628

35—How would you test an engine for compression?.....629

36—How does a cylinder of an engine with good compression crank?.....629

37—How are leaks through one or more valves indicated?.....629

38—How would you test for a leak at the valve cap, spark plug or relief cock?
.....629, 233

39—How would you test for a leak between the piston and cylinder walls?.....629

40—How would you test for a leak at the inlet valve?.....629

41—When spark plugs are constantly oily, and foul often, what does this indicate?
.....630, 652

42—How do spark plugs indicate the valve condition?.....630

43—How would you test a “valve seat” to see if valve seats tight?.....630

44—To obtain a slow, even pull and steady running at idling speed, is it important that there be no compression leaks?.....171

45—What is the advantage of “high compression”?.....627

46—What is the disadvantage of “high compression”?.....627

47—Why is an engine more subject to overheating if compression is higher?...627

48—Is it desirable to have large valve openings and long periods of exhaust openings, if high compression is used?.....627

49—Where are spark plugs usually placed when valves are “overhead”?.....627

50—Is it desirable to eliminate “valve pockets” when using a high compression, and is the “L” type cylinder more subject to valve pockets?.....627

51—Is the “maximum compression” determined when throttle is wide open?.....627

52—If a smaller charge is taken into the cylinder, then the compression would be less, would it not?.....626

53—State the variety of causes “faulty compression” could come from?.....626

54—What is meant by a “compression knock”?.....640

54a—What is a “spark knock”?.....639

54b—How does a knock caused by “high compression” sound?.....640

55—How is it possible to sometimes reduce compression on an engine if it overheats and you are sure it is caused by too great a compression?.....640

56—On engines using kerosene as fuel, what is the average compression in pounds? (foot-note).....627

57—What is the compression on the Hudson?.....627

57a—State other causes of loss of power.....626

58—Will the power of an engine be less if the compression pressure is low?....628

59—Will the power of an engine be greater if the compression pressure is greater?
.....628

60—Is the most frequent cause of "loss of compression" due to leaky or pitted valves and piston rings?.....628

Valve Adjustments.

61—How would you determine if the valves needed regrinding or reseating?....630

62—What is meant by "grinding a valve"?.....630, 631, 632

62a—What is meant by "reseating a valve"?.....630, 631, 632

63—How would you test to see if a valve needed grinding?.....630

64—What would be the "first" thing to do when starting to grind valves?.....630

65—What would be the "second" thing to do when starting to grind valves?.....631

66—What would be the "third" and "fourth" things to do?.....631

67—After grinding, what would you then do?.....631

68—What pressure is best for grinding valves?.....631

69—Should "valve clearance" be adjusted after grinding valves?.....631

70—How does grinding a "cage" type valve differ from grinding a valve in a "T" or "L" head type cylinder?.....631, 632

71—How would you grind the valves in a "detachable cylinder head"?.....636

72—How would you tell if valve which has been ground has a perfect seat?.631, 632

73—What is meant by "refacing a valve"?.....632

74—What is meant by "reseating a valve-seat"?.....632

75—Are many valves now made of hard Tungsten steel, and would it be possible to grind a valve of this type?.....632

76—How is a Tungsten valve refaced or ground to its seat?.....632

77—What is meant by "reaming valve guides"?.....632, 630, 609

78—When valve stems or the valve guide becomes worn, what is then necessary to do?.....630

79—How do "oversize valve stems" usually vary in size?.....630

80—Are "valve guides" sometimes "bushed," and can they be renewed?.....634

81—What is the average "clearance" on a Dodge between "valve guide" and "valve stem"?.....634

82—When valves are noisy, is it usually due to the valve clearance being too great? 634

83—How is this overcome?.....634

84—Will improper valve clearance cause lack of power? How?.....635, 94, 95

85—How would you determine which valve was noisy?.....635

86—If no space at all is left between the valve stem and plunger (or tappet), what would be the result?.....635, 634

87—Is the exhaust valve given more clearance than the inlet valve on some engines, due to its heating more? (foot-note).....634

88—What are valve springs for?.....92, 635

89—If the springs lost their tension, what is the result?.....635

- 90—What would be the reason for missing explosion from a weak exhaust spring?..635
 91—What is the result if inlet valve springs are too weak?.....635
 92—Will this also cause noise at the cams? How?.....635
 93—How would you test for a weak exhaust spring?.....635
 94—How would you increase the tension of a valve spring?.....635

Knocks.

- 95—Name the different parts of an engine which would likely cause a knock if loose or worn.....635, 790
 96—How would you proceed to locate the knock?.....635, 638
 97—Would you first assure yourself that the knock was not due to minor causes?..635
 98—State what these minor causes would be.....635
 99—What is meant by "piston slap"?.....637
 100—Are "aluminum alloy" pistons more subject to "piston slap" than "cast iron" pistons? Why?.....637, 638
 101—What troubles will cause a knock on a hill but not on the level ground?..637, 790
 102—How can the "lean mixture" trouble be remedied?.....637
 103—Will climbing a hill with spark too far advanced cause knocking?.....637
 104—Will cylinder nuts, if loose, cause a knock?.....637
 104a—Will fly-wheel, if loose, cause a knock?.....639
 104b—How would you test for a loose fly-wheel?.....638
 105—If connecting rods should be bent out of true would this cause a piston to slap? 637
 106—What is meant by "pre-ignition," and how would this cause a knock?.....639
 107—How would you proceed to locate the cause of a knock?.....639
 108—If a slight metallic rap is heard at 10 or 15 m.p.h. on level road, what is likely the cause?.....639
 109—If a slight knock is heard which slightly increases as the car mounts the hill, what is the cause?.....639
 110—How would a knock caused by carbon deposit be indicated?.....639, 790
 111—How would a knock caused by loose connecting rod on the crank shaft or piston pin be indicated?.....630, 790
 111a—State one method for testing for a loose connecting rod lower bearing....638
 112—How would a knock caused by worn crank shaft main bearing be indicated?..639
 113—How would you detect a "spark knock"?.....639
 113a—How would a broken piston ring be indicated?.....793
 114—What is meant by a "seized piston," and what causes it to seize? (foot-note).639
 115—How would you proceed to remedy a trouble of this kind?.....639, 202

Engine Bearings and Connecting Rods.

- 116—Are the main bearings of an engine a very important part?.....640
 117—Name the kind of bearing usually used on main bearings of crank shaft....640
 118—What kind is used on upper end of connecting rod?.....73, 644
 119—What is the difference between a "bearing" and a "bearing bushing"?.....73
 120—Are there two "bushings" in a main bearing on the crank shaft?.....641
 121—What is a "shim"?.....641
 122—Where are the shims placed?.....641
 123—Does the rear main bearing next the fly-wheel usually require attention first? Why? 641
 124—How would you proceed to take up a main bearing on a crank shaft?....641

125—How would you test after taking up?.....641

126—Is most of the wear on the lower bearing cap?.....643

127—If bushing is burned or cut, can it be scraped?.....643

128—How would you proceed to “scrape a bearing”?.....642, 643

129—What is meant by “marking” or “spotting in” a bearing?.....642

130—How often is this “spotting in” process repeated?.....642

131—After “scraping,” what is the next procedure?.....642

132—What is meant by “crank shaft alignment”?.....643

133—What is meant by a “scored” crank shaft?.....642

134—How would you remedy same?.....642

135—How would you “take up” on the lower end of a connecting rod bearing?..641, 642

136—How would you “scrape” a lower connecting rod bushing?.....642, 643

137—Would you first start with the rear connecting rod cap bushing?.....643

138—State exact procedure of “spotting in” a connecting rod lower end bushing..643

139—How would you test the adjustment of a connecting rod lower end on the
crank shaft?.....643

140—How would you proceed to test for “parallelism” of the connecting rods?
.....642, 646, 649, 659

141—Name the three “disalignments” possible in piston and connecting rod (foot-
note) 649

142—If the “small end” of connecting rod is worn what is necessary to do?....642
(Read “bearing pointers,” page 643, carefully.)

143—Are “oil grooves” in bearing bushings very important, and how should they
be arranged?.....644, 203

144—What is a “piston pin” for, and what is it made of?.....645

145—What is the difference between the “stationary piston pin” and the “oscillat-
ing piston pin”?.....645

146—How would you remove piston pin if stationary?.....645

147—How would you remove bronze bushing in “upper end” of connecting rod?..645

148—What “clearance” is allowed for connecting rod bearing at “upper end” on
the Oldsmobile? (foot-note).....645

149—How would you test to find out if lower connecting rod bearing was loose?
.....645, 837, 638

150—How would you “take up” or adjust same?.....645, 837

151—Is “side play” necessary? About how much?.....645

152—What is meant by “side play”?.....645

153—Give a brief outline of what you would do “first” in adjusting the main bear-
ings and connecting rod bearings of an engine, using the Waukesha as an
example? 837

154—What is the “second” procedure?.....837

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INSTRUCTION No. 46A.

Repairing and Adjusting Clutches, Transmissions and Axles.

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27a—If a dry plate disk clutch “grabs,” what is the remedy? Ans. Inject a mixture of one-third kerosene and two-thirds lubricating oil into clutch through adjusting screw hole (A, page 842) with an oil gun. Ordinarily, merely injecting kerosene will suffice.

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109—How would you proceed to adjust the “worm and nut” type of steering device? 691

110—Name the make of steering devices using the “worm and nut” principle.692, 693

111—Does a tight adjustment cause difficult steering?.....691

112—About how much play is permissible in steering wheel?.....691

113—Do steering devices require plenty of lubrication? What kind, and how?....691

114—Should all parts of steering device and rods and parts connected to it be well lubricated? Yes.

115—If wheels are out of “alignment,” will this make steering harder?.....683

116—If gears have become worn after long usage, so that adjustment will not prove satisfactory, how can one save the expense of new gears?.....690

117—What kind of a steering device is the Jacox? 692

118—What kind of a steering device is used on the Maxwell? 693

119—What kind of a steering device is used on the Studebaker? 693

120—What kind of a steering device is used on the Buick? 693

121—What kind of a steering device is used on the Overland? 693

122—What kind of a steering device is used on the Dodge? 693

(Read carefully, page 693, how to adjust each.)

INSTRUCTION No. 46C.

How to Use Tools and Make Repairs.

(Read page 695, how to solder aluminum, how to case harden, how to temper drills, tempering steel and brazing. All of this is a matter of reference when needed, therefore questions will not be asked on same.)

Measurements.

1—What is meant by the “thousandth part of an inch”?.....697

2—What is meant by the figures “.020”?.....697

3—How would you read decimals?.....697

4—What do the following figures mean: .3? 697

5—What do the following figures mean: .03? 697

6—What do the following figures mean: .003? 697

7—What parts of an ignition system are usually measured in “thousandths part of an inch”?.....	697
8—What is a “thickness gauge” for?.....	699, 697
9—What is a “micrometer” for?.....	698
10—What is the difference between a “Vernier caliper” and a “micrometer caliper”?	698
(Read pages 698 and 699 carefully.)	
11—What is a “drill gauge” for?.....	699
12—What is the first row of figures for on gauge? Page.....	699
13—What is the second row of figures for on gauge? Page.....	699
14—What are the figures from 1 to 60 (turned sideways) for?.....	669
15—What are the figures 228, 221, etc., under the holes for?.....	669
16—Suppose you had a cap screw, and saw by referring to table No. 100 (page 703) that it required 10x32 tap, how would you find the proper drill to use with this gauge?.....	699
17—What divisions are machinists’ steel rules of 6-inch length usually divided into?	700
18—What is a “screw pitch gauge” for?.....	700
19—Name the different kinds of chisels.....	700
20—What is a “center punch” used for?.....	700
21—What is a “cold chisel” for?.....	700
22—What is a “cape chisel” used for, mostly?.....	700
23—What is a “diamond point chisel” used for, mostly?.....	700
24—What is a “scriber” used for, mostly?.....	700

Bolts, Screws and Nuts.

25—Are nuts generally used on cap screws?.....	701
26—Are nuts generally used on bolts?.....	701
27—What kinds of nuts are used on bolts?.....	701
28—Where is the measurement of the diameter of a bolt or screw usually taken?..	701
29—What is the difference between the U.S.S. and S.A.E. capscrew?.....	701
30—What is the difference between the S.A.E. bolt and the S.A.E. cap screw?..	701
31—What is the difference between a “capscrew” and a “machine bolt”?.....	701
32—What is the difference between an S.A.E. bolt and U.S.S. cap screw?.....	701
33—What is the difference between a U.S.S. bolt and U.S.S. cap screw?.....	701
34—What is the difference between a machine screw and a machine bolt?.....	701
35—Will a wrench that fits a U.S.S. cap screw fit an S.A.E. cap screw?.....	701
(Read the other paragraphs on page 701 about wrenches.)	
36—What is a “stud” and where is it usually placed?.....	701
37—What are “taper-pins” for?.....	701
38—What are “set-screws” for?.....	701
(Note illustrations of other kinds of bolts and screws on page 701.)	

Thread.

39—Make a sketch of fig. 8 and name the parts of a thread.....	702
40—What is meant by the “angle” of a thread?.....	702
41—What is meant by the “pitch” of a thread?.....	702
42—What is meant by the “root diameter”?.....	702
43—What is meant by the “basic diameter”?	702

44—What is the difference between the “sharp V thread” (U.S.S.) and the “Whitworth oval” thread?.....702

45—What is meant by the “flat” of a thread?.....702

46—What kind of a thread is the U.S.S. and S.A.E.?.....702

47—What is the difference between the U.S.S. and S.A.E. threads?.....702

48—How can the number of threads to an inch be measured?.....702

49—What is meant by the “pitch” of a thread?.....702

50—Where are fine threaded screws used most?.....702

51—Where are coarse threaded screws used most?.....703

52—What kind of thread is there used most for bolt work?.....702

53—What kind of thread is there used most for pipe work?.....702

54—What are tables 101, and 102, page 703, for?.....702, 703

55—Is the “sharp V thread” favored much?.....702

56—Is the length of thread on a cap screw more than on a bolt?.....702

57—What is the purpose of table No. 100?.....703

58—What is each column for?.....703

59—Do you understand tables Nos. 101, 102 and 103 thoroughly?.....703

60—State what each column is for.....703

61—How many threads per inch has a ¼-inch S.A.E. tap?.....703

62—How many threads per inch has a ¼-inch U.S.S. tap?.....703

63—How many threads per inch has a ¼-inch pipe tap?.....703

64—Do S.A.E. cap screws have a finer thread, consequently more to the inch?...703

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66—What two classes are dies divided into?.....704

67—Are dies also adjustable?.....704

68—How are dies marked?.....704

69—What is meant by “clearance of a bolt or nut”?.....704

70—What is a “die stock” for?.....704

71—What is a “screw plate set”?.....704

72—Can threads be cut on a lathe?.....704

73—When a thread is cut on the outside as (9), is it called a male thread, and when inside (12), a female thread?.....704

Screw Taps.

74—What are “screw taps” for?.....704

75—What are “machinist’s hand taps” used for?.....704

76—What are “pipe taps” used for?.....704

77—What is the difference between a ⅜-inch “machinist’s hand tap” and a ⅜-inch “pipe tap”?.....704

78—What is a “taper tap” for?.....704

79—What is a “follower tap” for?.....704

80—What is a “bottoming tap” for?.....704

81—What are “flutes” in a tap, and what is the object of same?.....704

82—Briefly state how you would use a tap.....705

83—What kind of lubricant would you use?.....705

84—How would you make a tap cut oversize?.....705

85—How are taps marked?.....705

86—What sizes do taps run in, from No. 1 to 30?.....705

87—What sizes do taps run in, numbers above 30?.....	705
88—What size taps are used most?.....	705
89—What size is the maximum used in auto work?.....	705
90—What size tap is used for ½-inch spark plugs?.....	705
91—What size taps is used for S.A.E. 7/8-18 spark plug?.....	705

Drills.

92—What are twist drills used for?.....	706
93—What are flute drills used for?.....	706
94—What is the “shank” of a drill?.....	706
95—Where are “straight shank” drills used?.....	706
96—Where are “taper shank” drills used?.....	706
97—What size drills use a No. 1 taper shank?.....	706
98—What size drills use a No. 2 taper shank?.....	706
99—What size drills use a No. 3 taper shank?.....	706
100—What size drills use a No. 4 taper shank?.....	706
101—Are drills from 1½” to 80 numbered and lettered?.....	706
101a—Is a No. 80 drill larger or smaller than a No. 70?.....	706
102—What size (in thousandths of an inch) is a No. 80 drill?.....	706
103—Do drills from No. 80 to No. 1 bear numbers or letters to indicate their size?.....	706
104—How do drills No. 80 to No. 1 range in size?.....	706
105—What size (in inches or parts of an inch) is a No. 1 drill?.....	706
106—Suppose you wished to drill a hole for a tap to cut a ¼-inch U.S.S. thread with a pitch of 20 threads, what size drill would you use? (table 101).....	703
107—What size or number of tap would you use to tap a ¼-inch U.S.S. thread?.....	703
108—How would you find the number of drill to use for a ¼-inch U.S.S. tap?.....	703
109—Suppose a tap was marked “14-20,” what would this designate?.....	703
110—What size tap would you use for a ¼-inch S.A.E. thread? (table 102).....	703
111—Suppose it was not marked ¼-inch, but had a number on it, what would that number likely be?.....	703
112—Would the same tap which would tap a U.S.S. ¼-inch thread, tap an S.A.E. thread? What would be the difference? (table 102).....	703
113—What size or number of drill would be used for a ¼-inch S.A.E. tap? (table 102)	703
114—What size (in fractions of an inch) is a No. 4 drill? (foot-note).....	703
115—Would the same drill do for either a U.S.S. or S.A.E. tap? (under table 102).703 (Note the drill gauge (page 699) will instantly tell the size drill to use for different size taps. It will also tell the size drill from 1 to 45 in decimals. For instance, a No. 1 drill is .228.)	
116—If a tap is marked “¼-20,” what would this mean?.....	705
117—If a tap is marked “¼-28,” what would this mean?.....	705
118—Suppose you wished to tap for a “pipe thread” of ¼-inch size, what size drill would you use? (table 103).....	703
119—What is the decimal equivalent of 27-64ths? (table 106).....	706, 541
120—What size tap would be required for cutting a thread in this size hole?.....	703
121—How many thousandths of an inch would this tap differ from the ½-inch tap?.....	703
122—State a simple method of finding the size drill to use for tapping (fig. 1)....	706
123—Briefly state the four factors necessary in sharpening drills.....	707
124—Briefly state how you would proceed to drill.....	707
125—How would you measure the length of “cutting lip” of a drill?.....	707

126—How would you measure the “angle” of a drill?.....707

127—What kind of an edge is a “beveled edge”?.....707

 (Read carefully, 9 to 17, under “Drilling,” page 707.)

128—How would you lay out work for drilling?.....707

129—What is meant by “scribed”?.....707

130—When drilling a piece of thick metal, and drill has a tendency to bore crooked or off center, how can it be re-centered?.....707

131—What are “reamers” for?.....706

132—What kind is a “taper reamer”?.....706

133—What is meant by “draw filing”?.....708, 643

134—What are “keys” (as used on shafts) for?.....708

135—Name the different kinds.....708

136—What kind of a key is a “Woodruff key”?.....708

137—What kind of a key-way does a Woodruff key require?.....709

138—What is a “drift”?.....709

 (Read and thoroughly study pages 709, 710 and 711.)

Soldering.

139—What is a “soldering copper”?.....711

140—By what other name is it mostly known? (fig. 2).....711

141—Must a soldering copper be “tinned”?.....711

142—What is meant by “tinning,” and how is it done?.....711

143—What is necessary to do a good soldering job?.....711

144—How is soldering acid prepared?.....711

145—Must a soldering copper be red hot?.....711

146—What is meant by “hard soldering”?.....711

147—What is meant by “soft soldering”?.....711

148—What is a “blow torch” for?.....711

149—Briefly state how you would fill and operate a blow torch.....735

150—What is the difference between a “blow torch,” as shown on page 735, and a “brazing torch,” shown on page 712?.....712

151—Could gas be used to heat a soldering iron?.....696

152—What is a “ladle”?.....696

153—What is meant by “wiping a joint”?.....712

154—What is meant by “annealing”?.....713

155—How would you proceed to anneal copper tubing?.....713

156—What kind of a metal saw would you use for iron and steel?.....713

157—What kind of a metal saw would you use for brass and soft metals?.....713

158—What kind of a metal saw would you use for brass or steel tubing?.....713

 (Read page 714 carefully. Read page 715, how to test radiators.)

Gaskets.

159—What are gaskets used for?.....717

160—State the different kinds.....717

161—Where are copper or brass gaskets generally used?.....717

162—Is paper sometimes used for gaskets?.....717

 (Read page 716 carefully; how to cut gaskets.)

163—What is shellac used for?.....716

164—How would you mix shellac?.....716

 (Note illustration on page 738 showing a convenient method for keeping shellac air-tight.)

- 165—Where are gaskets used on spark plugs?.....717, 235
 166—What kind of a gasket is used?.....239

Oxy-Acetylene Welding.

- 167—Name the two types of oxy-acetylene outfits.....718
 168—What do the parts of the stationary outfit consist of?.....718
 169—What do the parts of the portable outfit consist of?.....718
 170—Briefly state how a weld is made.....718
 171—How is acetylene usually supplied?.....718
 172—What is meant by “autogenous welding”?.....719
 173—Name the parts of a welding outfit?.....719
 174—How is the “welding flame” obtained?.....719
 175—How is the welding flame adjusted?.....719
 176—What is the temperature of the oxy-acetylene flame?.....719
 177—Why is “pre-heating” necessary, and what does it mean?.....719, 721
 178—What are “filling rods” used for?.....719
 179—What are “fluxes” used for?.....719
 180—What determines the size of the “blow pipe tip”?.....719
 181—Is most of the so-called “wrought iron,” mild steel?.....721
 Read carefully how to weld mild steel.....721
 Read carefully how to weld hard steel.....721
 Read carefully how to weld nickel steel.....721
 Read carefully how to weld vanadium steel.....721
 Read carefully how to weld chrome steel.....721
 Read carefully how to weld malleable cast iron.....721
 Read carefully how to prepare parts for welding.....721
 Read carefully how to weld cast aluminum.....721, 723
 Read carefully how to weld copper, bronze, brass and lead.....723
 Read carefully how to weld in a patch.....723
 Read page 720 carefully. Note the flame in fig. 4.
 182—State some of the other uses for a welding flame.....723
 183—What is meant by “oxy-acetylene cutting”?.....724
 184—Is an “oxygen regulator” used where material to be cut is over 3 inches
 thick? 724
 185—State the two kinds of oxy-acetylene cutting blow pipes.....724
 (Read pages 724, 725, 726, 727.)
 186—Can oxy-hydrogen be used for welding and cutting?.....725
 187—What is the “oxygen decarbonizer” used for?.....727, 726, 624

Silent Chains.

- 188—What are silent chains used for?.....21, 89, 728, 729, 411
 188a—State various methods of adjusting the tension of silent chains.....728
 (Read pages 728 and 729 carefully.)

INSTRUCTION No. 46D.

Useful Shop Hints and Devices.

The matter under this instruction is mostly miscellaneous, therefore questions will not be asked, but it is advisable to read each and every page carefully.

INSTRUCTION No. 47.
Commercial Cars.

1—Is the truck constructed along the same line as a pleasure car? How does it differ?.....747

2—What are the two usual motive powers of trucks?.....747

3—What type of engine do most trucks employ?.....747

4—What is the difference between the “worm drive” and the “chain drive” truck?..747

5—Does a chain driven truck use a solid or “dead” rear axle?.....747, 14

6—Does a worm driven truck use a “live” rear axle?.....747, 14

7—What are the disadvantages of double chain drive?.....19

8—Is the worm gear drive considered best?.....19

9—What is the average speed of a truck of ½-ton capacity?.....747

10—What is the average speed of a truck of 5-ton capacity?.....747

11—Briefly state the cause of wear of chains.....749

12—How is a chain cleaned and lubricated?.....749

13—How would you adjust chain tension?.....749

14—What kind of tires are generally used on trucks?.....749, 560, 561

15—How does the “Jeffrey Quad” truck differ from the usual type of truck?....748

16—How are the front wheels driven?.....748

16a—How are the rear wheels driven?.....748

16b—How many differentials are used, and what kind of front axle and rear axle is there used?.....748

17—How is the steering of the four wheels accomplished?.....748
(Read page 748 carefully.)

18—How would you “take in” or “let out” on wheel alignment of front wheels?..750

19—Briefly state how you would remove rear wheels on the Sheldon truck axle shown on page 750.....750

20—Briefly state how you would remove “worm” and “worm wheel carrier”.....750

21—Is the “worm” above the “worm wheel” on this axle?.....750

22—How often would you drain oil from rear axle, and what kind of oil would you put into it?.....750

23—How would you adjust the foot brake?.....751

24—How would you tighten up on the brake levers?.....751

25—Briefly state what you would do when using engine as a brake on low gear on a hill.....751
(Read other subjects of page 751 carefully.)

26—What are “trailers” for?.....746

27—How does a “hydraulic hoist” operate?.....746

28—How does the Ford truck differ from the Ford touring car?.....825

29—Is the operation of a truck similar (in most respects) to a pleasure car?.....749

30—Is magneto ignition often used on truck engines?.....749

Governors.

31—Are truck engines sometimes fitted with governor?.....839

32—What other kinds of engines are governors often used on?.....839

33—State the two reasons why governors are used.....839

34—State the different methods for driving governors.....839

35—What is meant by “transmission drive”?.....839

36—What is meant by “engine drive”?.....839

37—What is meant by “dual drive”?	839
38—Briefly explain the principle of the Pierce governor?	840
39—Briefly explain the principle of the Simplex and Duplex governor?	841
40—What difference is there between the Duplex and the Simplex governor?	841
41—Briefly explain the principle of the Monarch governor?	841, 842
42—How does it differ from the Pierce and Simplex governor?	841
43—What is meant by a “throttling” type governor?	757
44—What is meant by a “hit and miss” type governor?	757
45—On a stationary engine, when is the “hit and miss” principle generally used?	757
46—When is the “throttling type” generally used?	757
47—Would the Pierce, Simplex and Monarch be the “throttling” type?	839, 840, 841, 842
48—The difference then in using a “throttling” type of governor on automobile engine and using it on a stationary engine would be in the fuel used, would it not?	
(This does not hold true for all stationary engines, as some use gasoline fuel and a throttling type governor.)	
49—What is the difference between a “throttling” type governor and a “hit and miss” governor?	757
50—Briefly explain the principle of the governor used on the Waukesha engine.	835

INSTRUCTION No. 48.

Tractors.

(The student is not required to answer questions on the tractor subject unless he so desires.)

1—What kind of engines are there used on tractors?	753, 831, 832, 833
2—Is the tractor engine subjected to harder usage than an automobile engine?	
Why? (foot-note)	753
3—How are tractors usually driven?	753
4—Briefly explain the 10 tractor designs shown on page.	752
5—What kind of work must a tractor do?	752
6—Does “belt work” represent half of the work of a tractor engine?	753
7—What size tractor is best for average work?	753
8—Briefly state how you would determine the power to use for different soil, and why.	753
9—What kind of a carburetor is generally used on a tractor?	754
10—Is kerosene sometimes used?	754
10a—If kerosene is used as a fuel, how is engine first started?	754, 828
11—Must the kerosene be heated? How, and why?	754
12—Is water sometimes used? How, and why?	754
13—Briefly explain the principle of the Kingston kerosene carburetor.	754
14—Why are two carburetor bowls, or float chambers used, and how are they used?	754
15—What is an “air washer” for?	828
16—Briefly explain the principle	828
17—Briefly explain the principle of the Holley vaporizer.	827
18—What kind of an engine is used on the Ford tractor	826
19—How is the Ford tractor driven?	826
21—Name the parts of a Ford tractor.	826
22—Is the Ford tractor a “worm drive” system?	826

23—Where is the “worm gear drive” placed?.....826

24—What part does the “worm gear” drive?.....826

25—What is the “worm wheel” attached to?.....826

26—How is the Ford tractor steered?.....826

27—What kind of drive wheels has the Ford tractor?.....826

28—What kind of transmission is there used on the Ford tractor?.....826

29—What kind of fuel does the Ford tractor engine use?.....826, 827

30—Is gasoline used for starting?.....826, 827, 831

31—What does the compression vary from, on tractor engines using kerosene fuel? 827

32—What is the average compression which is considered best, when kerosene is used? 827

33—Does kerosene require more than a heated carburetor, if so, what else should be heated? 831

34—Does kerosene have a tendency to condense, if so, what trouble would this cause? 831

35—When engine smokes excessively from exhaust, and smoke is black, what does this indicate?.....831

36—For a heavy tractor to travel over all kinds of roads, is it necessary that it lay its own track, and why?.....829

37—Name the different kinds of treads employed.....829

38—Briefly explain what is meant by a “flat wheel tread”.....829

39—Briefly explain what is meant by a “chain tread”.....829

40—Briefly explain what is meant by a “rail track tread”.....829

41—What is the weight of tractor supported upon when a rail track tread is used?.829

42—How is the chain driven?.....829

43—What is the difference between the “chain tread” and the “rail track” tread?.829
(Study fig. 4. page 829, carefully.)

44—What is meant by a “caterpillar” tractor?.....829, 830

45—Briefly state the names of parts of the caterpillar tractor shown on page....830

46—How is the transmission of power to drive system usually arranged on a tractor? 831

47—What type of clutches are generally used?.....831

48—Is a “clutch lever” used instead of a “clutch pedal” quite often?.....831

49—How many speed changes are there usually in transmission?.....831

50—What speed does the “Twin-City” tractor, page 830, travel when on “high-speed”? 830

51—What speed does it travel when on “low speed”?.....830

52—What speed does it travel when on “reverse”? 830
Read specifications of the Twin City carefully.....830

53—How are tractors steered?.....831

54—When there are three wheels to a tractor, how is it steered?.....831

55—When there are four wheels to a tractor, how is it steered?.....831

56—What is the weight of the Cleveland tractor, and would it be termed a light tractor? 831, 830

57—Where is the power plant located on the Cleveland tractor?.....831

58—What size engine is there used on the Cleveland tractor?.....831

59—What speed does engine crank revolve when tractor travels 4 m.p.h.?.....831

60—What speed does engine crank revolve when tractor travels 3½ m.p.h.?.....831

61—What type of clutch is there used on the Cleveland tractor?.....831

61a—What type of carburetor is there used on the Cleveland tractor?.....831

62—Does the Twin City tractor engine use gasoline to start on, and kerosene to run on?.....832

63—Is a Stewart vacuum system, as explained on page 165, used with this engine?..832

64—What size are the engine cylinders?.....832

65—What is the speed of engine?.....832

66—Is a governor fitted to this engine?.....832

67—What does the governor operate in the carburetor, and would it be the “throt- tling” type? 832

68—What heats the carburetor mixture?.....832

69—What type of ignition system is there used on this engine?.....832

70—How does the K.W., model H magneto, differ from the HK?.....832

71—How does the K.W., model HK magneto, differ from the HT?.....832

72—How does the K.W., model HT magneto, differ from the HTK?.....832

73—What is meant by an “impulse starter”?.....832

74—Where is the K-W Impulse starter located?.....832

75—Briefly explain the action of impulse starter.....832

76—What is the advantage of impulse starter?.....832

INSTRUCTION No. 49.
Other Types of Engines.

(Note.—Student is not required to answer these questions under Instruction 49 unless he so desires.)

Motorcycle.

1—What kind of engines are generally used on motorcycles?.....755

2—Are air cooled cylinders generally used?.....755

3—At what angle are “twin cylinders” usually placed?.....755

4—When cylinders are at an angle of 42 degrees, and No. 1 piston is on top of compression stroke, where is the piston of the other cylinder?.....846

5—If No. 1 fires and travels 42 degrees on its power stroke, where is No. 2 piston?..846

6—If No. 1 piston makes a complete revolution, how far in degrees will it have traveled? 846

7—How far in degrees will No. 2 piston have traveled?.....846

8—Therefore, when No. 1 travels 360 degrees, must No. 2 travel 360 degrees plus 42 degrees, or 402 degrees before it fires, or No. 1 will fire again, 318 degrees after No. 2 fires? Is this correct?.....846

(Read page 846 carefully.)

9—How are the connecting rods usually placed when twin cylinders are used?..755

10—What kind of transmission is there used on some motorcycles?.....845, 844

11—Are they 2 and 3 speed, and similar to an automobile transmission?....844, 845

12—What kind of a device is a “neutral counter shaft,” and what is it for?.....844

13—How is engine started on the motorcycle, fig. 1, page 844, when a one-speed device is used?.....844

14—How is starting accomplished when a three-speed gear box is used?.....844

15—Where is the Indian starter operated?.....844

16—What kind of a clutch is there used on the Indian motorcycle?.....845

17—Explain its operation.....845

18—What kind of a carburetor is there used?.....845

19—Briefly explain its principle.....845

20—What does the right handle bar grip (fig. 2) control?.....844

21—What does the left handle bar grip (fig. 2) control?.....844

22—What kind of ignition is used?.....844

23—How is the clutch controlled?.....844

24—How would you proceed to start the engine on the three-speed model (Harley Davidson)? 843

25—Briefly explain the electric system.....843

26—Briefly explain the action of the “vacuum controller” formerly used.....843

27—What type, size, and at how many degrees angle are cylinders placed on the Indian engine?.....Insert No. 3

28—What type, size, and at how many degrees angle are cylinders placed on the Harley Davidson engine?.....Insert No. 3

29—What is the bore and stroke of the engine shown, of the Indian? Insert No. 3

30—What is the bore and stroke of the engine shown, of Harley Davidson? Insert No. 3

31—How are the valves placed on the Indian?.....Insert No. 3

32—How are the valves placed on the Harley Davidson?.....Insert No. 3

33—Briefly explain the action of the inlet valve on the Indian.....Insert No. 3

34—Briefly explain the action of the inlet valve on the Harley Davidson. Insert No. 3

35—Briefly explain the action of the exhaust valve on the Indian....Insert No. 3

36—Briefly explain the action of the exhaust valve on the Harley Davidson. Insert No. 3

37—What is meant by a “compression relief,” and where located on the Indian? Insert No. 3

38—What is the purpose of the “compression relief” on the Indian?..Insert No. 3

39—Is there an “exhaust compression relief” on the Harley Davidson, and where is it located, and what controls it?.....Insert No. 3

40—Is there a “crank case compression relief” on the Harley Davidson, and where is it located, and what purpose does it serve? Explain its action..Insert No. 3

41—Briefly state the path or flow of oil of the Harley Davidson.....Insert No. 3

42—How would you increase the oil supply?.....Insert No. 3

(Note.—Study the ignition system of the Indian on this No. 3 Insert and also the ignition timing and particularly the valve operation.)

Two Cycle Engine.

43—How many types or kinds of two-cycle engines are there in general use? Name them.....757

44—What is the “twoport” type adapted for?.....757

45—What is the “three-port” type adapted for?.....757

46—What is the “two and three port” type adapted for?.....757

47—Why is a two-cycle engine called a “valveless” type of engine?.....757

48—How many strokes of piston are there to the four operations of intake, exhaust, compression and explosion?.....757

49—How many strokes of piston are there to the same operation on a four-cycle type engine?.....757, 58

50—What type engine is shown in figs. 1 and 2, on page 756?.....756

51—What is occurring in engine, fig. 1?.....756

52—What is occurring in engine, fig. 2?.....756

- 53—What is a baffle plate for?.....756
- 54—Does exhaust port open slightly before inlet port?.....756
- 54a—If inlet and exhaust ports are open at the same time, what would prevent the fresh charge from passing out the exhaust port with the exhaust gases?.....756
- 55—Explain the action of a mixing valve used on a two-cycle engine?.....756
- 56—Explain the action of a carburetor used on a "two-port" type engine.....756
- 57—Is a vacuum formed in crank case when piston travels up?.....756
- 58—Does the vacuum thus formed create a suction and cause the gas to be drawn into crank case?.....756
- 59—Where is the gas drawn from?.....756
- 60—How is the gas then admitted into cylinder?.....756
- 61—After explosion stroke, state how and when the gas passes out the exhaust port 756
- 62—What opens and closes the exhaust port?.....756
- 63—Does the exhaust port open slightly before the inlet port? How?.....756

Stationary Internal Combustion Engine.

- 64—Does the stationary type of internal combustion engine usually operate on the four-cycle principle?.....757
- 65—Is the stroke usually larger than the bore?.....757
- 66—What is the speed of a stationary engine?.....757
- 67—Is the speed constant?.....757
- 68—What device keeps the speed constant?.....757
- 69—State the two types of governors generally used on stationary engines.....757
- 70—Explain the difference between the "throttling" type governor and the "hit and miss" type.....757
- 71—Explain the principle and action of the governor on the engine, fig. 20.....757
- 72—What type of ignition is generally used on the stationary engine?.....757
- 73—Explain the action of the "wipe spark".....215
- 74—How is the exhaust valve operated on the engine, fig. 3?.....757
- 75—How is the exhaust valve operated on the engine, fig. 20?.....757
- 76—Is the exhaust valve held open by governor action on engine, fig. 20? When, and for what purpose?.....757
- 77—Are inlet valves sometimes of the "automatic type" on stationary engines?...757
- 78—What is meant by an "automatic inlet valve"?.....91
- 79—What kinds of fuel can be used on stationary engines?.....757
- 80—When kerosene is used, must it be heated?.....757

Diesel Engine.

- 81—Briefly explain the principle of the Diesel engine.....758
- 82—What part is the injection valve, and what purpose does it serve?.....758
- 83—What operates the injection valve?.....758
- 84—What is the air admission valve (A) for?.....758
- 85—What is the exhaust valve (E) for?.....758
- 86—During the admission or inlet stroke, is cylinder filled with air only?.....758
- 87—During compression stroke is this air compressed to about 500 pounds per square inch, and does this produce a higher temperature?.....758
- 88—When piston reaches upper end of the compression stroke is fuel then admitted? 758
- 89—Is the fuel oil pumped into the space around the valve spindle?.....758

90—Is the air for fuel injection admitted behind the oil, to blow the oil into the cylinder when valve opens?.....758

90a—Is this injection air supplied by separate air compressor, driven from engine shaft? 758

90b—What ignites the gas?.....758

91—Briefly explain the action of the power stroke.....758

92—How is the quantity of fuel governed?.....758

93—When does the exhaust valve open?.....758

Gas Producer.

94—Explain what is meant by a gas producer.....757

95—What is the gas thus produced used for?.....757

96—Name the two types.....757

Miscellaneous.

97—What is a “service” car for?.....759

(Read pages 759, 760, 761, 762.)

Steam Car.

(Questions will not be asked on this subject. Read pages 763, 764, 765 and details of a steam car will no doubt be understood.)

FORD SUPPLEMENT.

(The student is not required to answer questions under this subject unless he so desires.)

(Read pages 766 and note location of parts. Read data on page 770.)

1—What part of a Ford is the Chassis?.....770

2—State the different “units” the Ford Chassis is divided into.....770

3—Is it well to remember these units when repairing?.....770

4—Before starting engine, what is necessary to do?.....771

5—What does the hand lever do when it is pulled back?.....771

6—How would you retard the spark lever?.....771

7—Where is spark lever placed, and what movement retards, and what movement advances the spark?.....771, 805

8—What does spark lever connect with?.....805

9—Where is the throttle lever placed, and what does it connect with?...771, 799

10—Where is the spark lever placed for starting?.....771

11—Where is the ignition switch located?.....771

12—Where is it placed when starting and running?.....771

13—How would you prime the carburetor for easy starting?.....771, 798

14—Is there a dash adjustment for the carburetor, and where is it located?...798

15—Suppose engine is difficult to start, state briefly procedure in starting it...798

16—Briefly state how you would crank a Ford engine.....771

17—After engine is started, how would you start car?.....771

18—Briefly state how you would reverse car.....771

19—Briefly state how you would stop car.....771

20—Briefly state how the speed of car is controlled.....771

21—When running where would you place spark lever?.....771

22—When running where would you place throttle lever?.....771

23—When should spark be retarded while running?.....771

- 24—How is oil put into engine?.....772
- 25—When engine is new, how much oil would you put into crank case?.....772
- 26—After engine has been limbered up, how much oil should there be in crank case? 772
- 27—How should you test the oil level?.....772
- 28—Briefly explain the principle of oiling the engine (see splash system, semi-circulating) 197
- 29—What kind of oil is recommended for use in engine?.....772
- 30—Should graphite ever be used in a Ford engine? Why not?.....772
- 31—How should you proceed to drain the oil?.....772
- (Read the other parts of page 772 carefully.)

Ford Steering.

- 32—Briefly explain how the Ford front wheels are steered and the parts that constitute the steering system.....773
- 33—Instead of having gears at the bottom of the steering post, where are they located, and what is at the bottom of steering post?.....773
- 34—What purpose do the steering reduction gears serve?.....773
- 35—What is the pinion (B, fig. 8) connected with?.....773
- 36—Is the steering rod fitted with a flange, and are there three small gears mounted on studs on this flange?.....773
- 37—Then when steering wheel is moved the steering rod is also moved, but through the movement of the three gears, is it not?.....773
- 38—How can you gain access to these gears?.....773
- 39—How can the steering wheel be removed?.....773
- 40—How would you tighten steering gear?.....773
- 41—If ball and socket, which is placed on rod A and B, fig. 9, becomes worn from lack of oil, how would you take up on the wear?.....773
- 42—What part is the "spindle arm"?.....773
- 43—Are there bushings in these spindle arms?.....773
- 44—How would you remove the bushings?.....773
- 45—How would you fit a new bushing?.....773, 792
- 46—How would you proceed to remove the front wheels?.....774
- 47—How would you proceed to test the front wheels?.....774
- 48—How would you proceed to adjust the front wheel bearings?.....774
- 49—How would you proceed to remove the front axle?.....774
- 50—What is meant by "transposing tires"?.....774
- 51—What care should the front springs receive?.....774
- 52—What is meant by "alignment of the wheels"?.....774, 683
- 53—How would you proceed to align the front wheels?.....774

Ford Transmission.

- 54—How does the Ford transmission differ from a gear type transmission?.....775
- 55—Where is the Ford transmission mounted?.....775
- 56—Where is the Ford clutch located?.....775
- 57—How many speeds "forward" does a Ford transmission give?.....775
- 58—How many speeds "reverse" does a Ford transmission give?.....775
- 59—Where are the "planetary gears" located?.....775
- 60—Where is the "reverse drum" located?.....775
- 61—Where is the "slow speed drum" located?.....775
- 62—Where is the "brake drum" located?.....775

- 63—Where are the “steel disks” of clutch located?.....775
- 64—Where is the “ring” which presses against the steel disks located?.....775
- 65—For what purpose are the “fingers” which press against the ring?.....775
- 66—For what purpose is the “collar” which shifting yoke works in?.....775
- 67—For what purpose is the “spring”?.....775
- 68—For what purpose is the adjustment screw for clutch?.....775
- 69—Are bands placed around the “reverse drum,” “slow speed drum” and “brake drum”? 775
- 70—Is foot pedal (B-) connected with brake drum band, and what action takes place when the foot brake pedal is depressed?.....777
- 71—Is clutch foot pedal (c) connected with the slow speed band, and when depressed full forward, does this tighten the slow speed band?.....777
- 72—Is clutch foot pedal (c) also connected with clutch? How?.....777
- 73—When clutch pedal (c) is allowed to come part way back, does this cause spring to release its tension on clutch? How?.....777
- 74—In starting car off from a standstill, and you wished to start on low gear, you would depress clutch pedal (C) as far forward as it would go, would you not?.....777
- 75—This section would cause spring tension to be taken off clutch and slow speed would be tightened, and car would start off on slow speed. Is this correct?..777
- 76—What position would “side hand lever” be in during this operation?.....777
- 77—Is the spring tension off from the clutch when side hand lever is in center vertical position?.....777
- 78—Then to throw on “high gear,” after starting on “low gear,” is the clutch pedal released and side hand lever thrown full forward?.....777
- 79—When side hand lever is thrown full forward, does this action cause eccentric (C) to move from under screw (B), thus permitting clutch spring tension to be applied to the clutch fingers, which press against clutch push ring, and cause the clutch disks to take hold, and is car then in “high gear”?....777, 775
(Study the action of the hand lever in relation to the eccentric (C) and screw (B) on page 777, and fig. 15A, page 776 and page 775.)
- 80—At the same time the clutch pedal is pushed forward, the side hand lever should also be pushed forward as far as it will go, so that when clutch pedal is released the high speed clutch is engaged. Is this correct?.....777, 775
- 81—Does “neutral” position mean when clutch spring tension is off of the clutch, and none of the bands on the drum are tightened? Yes.
- 82—Would “neutral” position be when side hand lever was in vertical position, or clutch pedal (C) was half way depressed? Yes.
- 83—Then when brake pedal is depressed and foot brake is applied, the clutch pedal should be in “neutral.” Is this correct? Yes.
- 84—When hand lever is in back position, is spring tension released by the eccentric (C) and screw (B), and are brakes on rear wheels tightened?.....777
- 85—If machine had a tendency to creep forward when cranking engine, what would likely be the cause?.....776
- 86—If clutch “slips,” what would likely be the trouble?.....776
- 87—If clutch “drags,” what would likely be the trouble?.....776
- 88—What kind of oil should be used in the Ford engine and transmission to prevent dragging of clutch?.....776
- 89—How would you proceed to adjust the clutch fingers?.....776
- 90—How is the transmission supported at the rear?.....776

91—When a transmission becomes very noisy is it probably due to the bushings in the second speed and reverse drums being worn, then what is advisable to do?.....776

92—How would you proceed to remove transmission?.....776

93—When transmission band linings are worn, what is the result?.....777

94—State the evidence of worn transmission bands.....777

95—How would you drive a Ford to protect the bands?.....777

96—How would you proceed to tighten the “brake” and “reverse” bands?.....777

97—Should the bands be adjusted so they will not drag?.....777

98—How would you proceed to tighten the “slow speed” band?.....777

99—What size band linings are there used?.....777

100—State procedure in removing transmission cover.....778

101—State procedure in removing bands.....778

102—What is the proper method of relining the bands, and is it similar to relining brake bands? 778, 688

103—What kind of rivets should be used?.....778

104—How would you proceed to install the bands after relining?.....778

105—Briefly state how you would proceed to replace transmission cover.....778

106—Is it necessary to adjust bands again (after installing new ones) after running a couple of hundred miles?.....778

Ford Transmission Assembly.

107—What do figures 19 to 19G, on page 779, represent?.....778

108—How many small disks are there in the clutch?.....778

109—How many large disks are there in the clutch?.....778

110—How are they assembled?.....778

111—What do the projections on the small plates (20D, page 779) fit into?.....778

112—Is the disk drum attached to the transmission shaft?.....778

113—What do the slots in the large plates or disks fit into?.....778

114—How is the “clutch disk drum” fastened to the transmission shaft?.....778

115—What causes the large and small disks to grasp, and how is this adjustment regulated? 778

116—Do the transmission shaft (TS) and small plates (20D) run free in the brake drum? 778

117—What does the “slow speed drum” fit over?.....778

118—How is the “driven gear” fastened to hollow shaft?.....778

119—What are the “triple gears” for?.....778

120—Are they fastened together in groups of three?.....778

121—Should they revolve freely and on what?.....778

123—What does gear (P) mesh with?.....778

122—What does gear (K) mesh with?.....778

124—What does gear (P1) mesh with?.....778

125—In assembling the groups (20 to 20C), in what position is the brake drum placed? 779

126—How is the slow speed drum then fitted?.....779

127—What is next procedure?.....779

128—Where are the Woodruff keys placed?.....779

129—How is the “driven gear” placed?.....779

130—Should the “triple gears” then be meshed, and with what, and how?.....779

131—Should the “triple gears” be tied with a string? Why?... .779

132—What is the second procedure?.....779

Fitting the Ford Clutch.

133—State procedure of fitting the clutch.....779

134—How would you arrange the “clutch disks”?.....779

135—Where would the “thrust plate” be when all disks are assembled?.....779

136—Where and how is the “clutch push ring” placed?.....779

137—How would you proceed to place the “driving plate”?.....779

138—How would you test to see if the “clutch disks” move freely?.....779

139—Briefly state how you would proceed to assemble the clutch spring parts...779

140—Should the adjusting screws (AS) be adjusted?.....779

Ford Rear Axle and Parts.

141—In how many parts is the axle housing made?.....780

142—Is the drive shaft enclosed? In what?.....780

143—Where and how is the drive shaft supported?.....780

144—Is the entire rear axle and drive shaft removed in one unit when repairs are
to be made?.....780

145—State how you would proceed to remove rear axle.....780

146—State how you would disconnect universal joint.....780

147—State how you would disassemble rear axle.....780

148—State how you would remove axle shafts.....780

149—State how you would remove drive pinion 780

150—State how you would remove differential gears 781, 782

151—State how you would remove rear wheels 781

152—Where are the cast-iron brake shoes located?.....781

153—How would you proceed to replace brake shoes?.....781

154—How would you equalize the pull on the rear hub brakes?.....781

155—Where is the driving shaft bushing located?.....781

156—What is the cause of excess of oil in the brakes and how is it remedied?...782

157—State the cause of grease leaks from rear axle.....782

158—What is the result if thrust washers are worn?.....782

159—Where is thrust washer located in differential housing?(see fig. 28).....781

Ford Power Plant.

160—Is the engine and transmission in one unit?.....783

161—State the specifications of the power plant.....783

162—State location of valves?.....783

163—Is the cylinder head detachable?.....783

164—Are cylinders cast “en-bloc”?.....783

165—What cooling system is used?.....783

166—What is the source of electric current for ignition?.....783

167—What make of carburetors are there used?.....783

168—What kind of transmission is used and does entire transmission revolve
when on high gear?.....783

169—Is the gasoline fed by gravity?.....783

170—What kind of engine lubrication system is used?.....783

(Read page 783, “Removing Power Plant.”)

171—Is the crankshaft a regular 180° four-cylinder type?.....784

172—What is the “firing order” of the Ford engine?.....784

173—How many cams are there on camshaft? (footnote).....784

174—What is the speed of camshaft?.....784

175—How many teeth has camshaft gear?.....784

176—How many teeth has crankshaft gear?.....784

(Note name of parts on page 784.)

Ford Valve Timing.

177—When does inlet valve open? 785

178—When does inlet valve close? 785

179—When does exhaust valve open? 785

180—When does exhaust valve close? 785

181—How would you proceed to obtain proper “valve clearance”?.....785

182—How would you proceed to check the valve-timing?.....785

183—How would you proceed to time the valves? 785

184—How would you proceed to mesh the timing gears?.....785

Ford Engine Connecting Rods.

185—What is the result of loose connecting rod bearings?.....786

186—What are some of the causes of loose connecting rod bearings?.....786

187—Is it necessary to drain oil from base to make repairs on connecting rods?..786

188—How would you proceed to adjust connecting rod bearings?.....786

189—How would you test for tightness?.....786

190—Should each bearing be fitted and tested before tightening all the cap bolts?.786

191—After adjusting the bearings what should be done?.....786

192—How would proceed to remove No. 4 connecting rod cap?.....786

193—How would you remove piston and connecting rod?.....786

194—How would you remove lower crank case cover?.....786

Ford Engine Main Bearings.

195—How is a worn main bearing detected?.....787

196—What are the causes of worn main bearings?.....787

197—Does the rear main bearing usually wear first? Why?.....787

198—How can you detect if rear main bearing is worn?.....787

199—Can rear main bearing be tightened without removing engine?.....787

200—How would you proceed to remove the center and front main bearing?.....787

201—How would you proceed to remove cylinder head?.....787

202—Briefly state the first, second, third, fourth and fifth procedure for adjusting the bearings. 787

Ford Engine Crankshaft and Camshaft.

203—How would you proceed to remove crankshaft? 788

204—How would you proceed to remove camshaft? 788

205—How would you proceed to install new push rods?.....788

Overheating of Ford Engine.

206—Read page 788 carefully and then briefly state causes of engine overheating..788

207—If water becomes frozen in radiator, does it usually freeze at the bottom first? 788

208—Is this because water comes from top of engine to top of radiator, and is then cooled as it passes through radiator? Yes.

209—State how you would proceed to thaw out frozen radiator.....788

Ford Radiator.

210—How would you proceed to clean a radiator?.....789

211—When removing a radiator should the lower hose be left on?.....789

212—How would you test a radiator for a leak?.....789

Ford Engine Troubles.

(Read bottom of page 800 carefully.)

213—If compression is poor and rings fit well, what may be the cause?.....790

214—How would you proceed to remove valves for grinding?.....790

215—How would you proceed to grind the valves?.....790

216—When valve seat is worn badly what is advisable to do?.....790

217—If valves fail to seat properly, what may be the cause?.....790

218—What is the result of weak valve springs?.....790

219—How can you detect a weak valve spring?.....790

220—State at least five reasons for cause of knocks.....790

221—How would you proceed to remove carbon deposit from cylinder and piston head? 790

222—State procedure in replacing cylinder head.....790

223—When are oversize valve-stems necessary?.....791

224—What is a “valve guide reamer” for?.....791

225—What is a “valve seat reamer” for?.....791

226—Can Ford valves be enlarged?.....791

227—What is a “valve refacer” for?.....791

228—What are “valve clearance adjusters” for?.....791

Ford Pistons and Rings.

229—What are Ford Pistons made of?.....792

230—What is the diameter?.....792

231—What kind of piston pin is there used?.....792

232—What diameter of oversize pistons can there be obtained?.....792

233—How many rings are there and where are they placed and what are the measurements? 792

234—Are the rings of the “eccentric” type?.....792

235—When oversize pistons and rings are fitted must cylinders be rebored or reamed? 792

236—What size is a standard oversize piston for a Ford engine? (foot-note).....792

237—What is an “aligning reamer” for?.....792

238—How much allowance or clearance is there allowed for crankshaft wear?....792

239—What parts of a Ford car can other reamers be used for?.....792

240—If cylinders are over-lubricated, what is the result?.....793

241—What are some of the causes of over-lubrication?.....793

242—How would you detect a broken piston ring?.....793

243—How would you remedy “piston pumping oil”?.....793

244—Should “chamfering” of the rings be tried before drilling a piston?.....793

245—What is meant by “piston clearance” and how much clearance is there on a Ford piston? 793

246—What is meant by “increasing compression” and is it advisable?.....793

247—What results from increasing compression?.....793

248—What is meant by “running-in” an engine and when is it necessary?.....793

249—Are the special wrenches shown on page 795 time-savers?.....795

Ford Gaskets.

250—State where gaskets are used on a Ford.....796

251—State where felt washers are used.....796

252—What kind of a gasket is used between the cylinder and cylinder head?.....796

253—Should shellac be used on this gasket? Why not?.....796

254—Must cylinder head be kept tight? Why?.....796

255—Could asbestos be used for a cylinder head gasket?.....796

256—If cylinder head cap screw threads become stripped, what is advisable to do?.....796

(Read pages 796, 797, carefully.)

Ford Carburetion.

257—Name the two makes of carburetors used on a Ford.....798, 160

258—What is the “dash adjustment” for and state its operation?.....798, 802

259—Briefly state how you would regulate this carburetor adjustment.....798

(Read paragraphs on “Starting Engine in Cold Weather”; “To Facilitate Easy Starting”; “Float Level Adjustment of Kingston,” page 798.)

(Read carefully the Construction, Principle of Operation and Troubles and Remedies of Carburetor, on page 799.)

260—Is it advisable to heat the “mixture” of a carburetor as it enters the cylinder, as well as the “air” taken into carburetor?.....160

261—What is a “Pitot tube”?.....800

262—Is this principle applied to the Schebler carburetor on page 800?.....800

(Read carefully page 800 and note the principle of a “Plain Tube Carburetor,” as it is a principle now in general use on many cars.)

263—What is the purpose and principle of an “auxiliary air valve”?.....801

(Read page 802 carefully.)

Ford Ignition.

264—Make a rough sketch showing the wiring of primary and secondary circuits used on the Ford.....803

265—How many “coil units” are there and where are they placed?.....803

266—Briefly state path of primary circuit.....803

267—Briefly state path of secondary circuit.....803

268—Explain the principle and construction of the commutator.....803, 805

269—At what speed (relative to crankshaft speed) does the commutator roller revolve? 805

270—What is the commutator roller attached to?.....805

271—How many contact points are there on the commutator?.....805

272—Make a sketch showing how you would connect same with spark plugs.....803

273—What parts of commutator are most likely to get out of order?.....804

274—How does cold weather affect the commutator?.....804

275—How would you remove commutator?.....804

276—State some of the commutator troubles.....804

277—How would you detect a short-circuit in the commutator wiring?.....804

278—How is the spark advanced or retarded?.....805

279—How would you proceed to set the time of spark on a Ford engine ignition system? 804, 316

Ford Magneto.

280—Does the magneto supply current for ignition, lights and horn?.....805

281—Are the magnets called the “rotating fields”?.....805

282—How many magnets are there?.....805

283—Do the magnets revolve in front of the coils, how close or what clearance? 805, 807

284—What are magnets attached to? (see fig. 86).....803

285—How many coils are there?.....805

286—Are these coils called the “stationary armature” and why?.....805

287—What are these coils attached to?.....805

288—How are the coils wound?.....805

289—What are ends of coils connected to?.....805

290—Is the electric current generated, alternating?.....805

(See page 265 for principle of Ford magneto.)

291—What does voltage vary from?.....805

292—How are the magnet poles placed; are like poles (N&N and S&S) together?.805

293—State cause of weak magnets.....805

294—State indications of weak magnets.....806

(Read page 808, “Testing for Grounds”; read pages 806, 807, on “Practical Pointers on the Repair of Ford Magneto.”)

(Read pages 807, 808, on “Remagnetizing Ford Magnets”; read “Ignition Troubles” carefully, on page 808; read miscellaneous matter on pages 809 to 825.)

AIRPLANE SUPPLEMENT.

There are no questions to this instruction but it is advisable for the student to read the subject carefully and take particular notice of the difference between an automobile engine and an airplane engine.

Also note the overhead camshaft drive systems so commonly used on airplane engines and further note the double valve system (dual valves) on page 927, as used on the Pierce Arrow automobile engine.

The matter referring to airplane ignition is also of value to the student, especially magnetos for airplane engines.

LIBERTY ENGINE SUPPLEMENT.

There are no questions to this instruction but the student is advised to read it carefully.

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CADMIUM TEST OUTFIT

FOR A STORAGE BATTERY

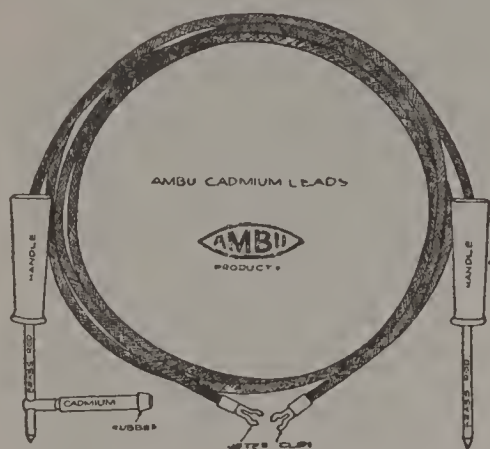


Fig. 1. Test Points and Cadmium

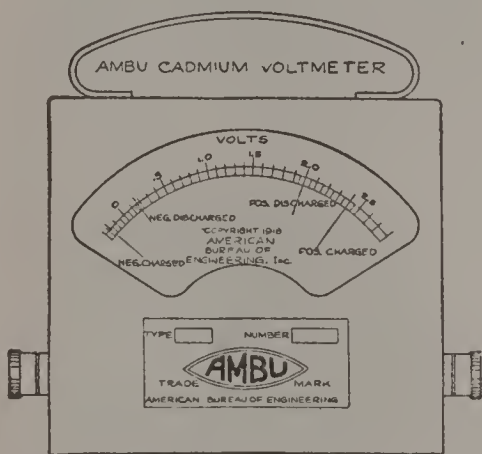


Fig. 2. The Special Cadmium Test Voltmeter

The condition of a storage battery is usually ascertained by taking a specific gravity reading of the electrolyte, with a hydrometer. A reading of 1,275 or above being usually considered as indicating a fully charged cell.

While specific gravity readings with a hydrometer should always be made, yet they should not be relied upon entirely.

For instance, a battery which gave entirely satisfactory hydrometer tests, may show a rapid drop in voltage when in use, yet this condition could not be foretold by hydrometer readings alone, because the hydrometer readings would not tell us the condition of either the positive or negative plates, and it is their condition which determines amount of energy in battery.

We may also take a voltage reading of the entire battery, while current is being drawn from the battery which gave satisfactory hydrometer readings. This would tell us if the plates were not in good condition, but it would not tell us which set of plates was at fault, because the voltage reading includes all positive and negative plates.

If we took a voltage reading of one cell, while battery is on charge, you can readily see that the test includes both positive and negative plates. Suppose the battery will not take a full charge, which set of plates is defective?

Therefore, to determine the condition of the positive and negative plates separately, we must make a test between each set of plates and some neutral substance. Theoretically, a number of substances could be used for the neutral substance, but for practical reasons Cadmium is used.

Cadmium is a metal, it looks like zinc, but is pure because there is no other substance mixed with it.

A Cadmium Testing outfit consists of two copper test points, one of which has a stick of Cadmium, about $3\frac{1}{2}$ " long and $\frac{1}{4}$ " di., riveted to it, as per fig. 1, and a special reading voltmeter, per fig. 2.

You will readily see that the advantage of the Cadmium Testing Outfit will soon pay for itself, as it will enable you to know which set of plates of a battery require cleaning or replacement and you can go right to the source of trouble without having to take entire battery apart.

If a battery will not hold its charge, or loses its charge quickly in use, the Cadmium test will tell you instantly where the trouble is.

If you propose doing battery repair work, you can turn out better work because you should never let a battery go out of your place unless the hydrometer readings are from 1.275 to 1.300; until the positive-to-Cadmium tests give at least 2.40 volts, and the negatives-to-Cadmium test gives about 0.175 volts.

PRICE

Complete Outfit, packed in a convenient case with complete instructions including Voltmeter and Cadmium Test Points and Cables, per figs. 1 and 2, \$25.00 Voltmeter, per fig. 2, only \$22.50—Cadmium Leads per fig. 1, only \$3.25.

Address A. L. Dyke, Elect. Dept., Granite Bldg., St. Louis, Mo.

A COMPLETE ELECTRICAL TESTING OUTFIT

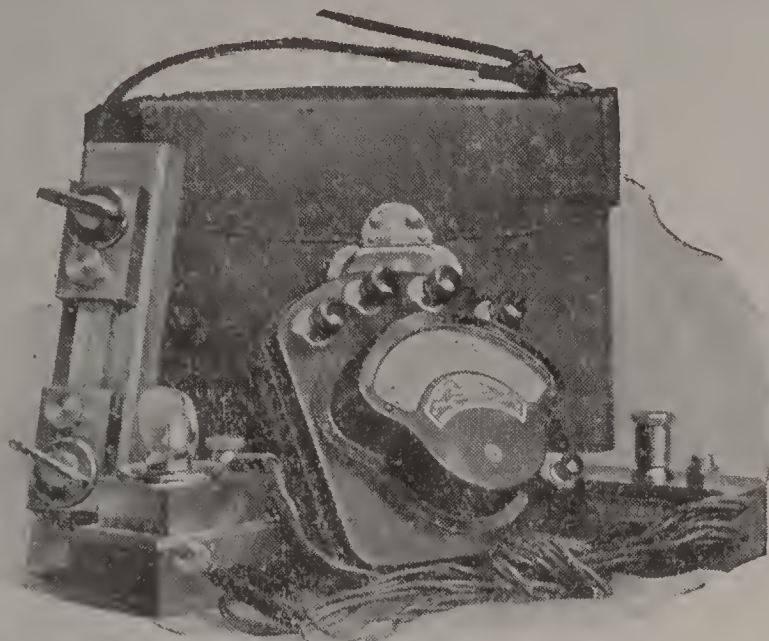


Illustration showing the model 280, Weston Volt-Ammeter, wire, three shunts and leather case.

Weston Model 280 Garage Testing Volt-Ammeter. It is complete with **full instructions**, showing how to make all tests.

It will prove of invaluable assistance to employees in any garage. This instrument is extremely accurate and serviceable, perfectly deadbeat, quick in action, shielded from the disturbing influence of external magnetic fields, exceptionally permanent and durable.

It has six ranges as follows: 30 volts, 3 volts and .1 volt (100 milli-volts); 300 amperes, 30 amperes and 3 amperes.

The 30 volt range is useful for determining the voltage of the starting or lighting system of batteries.

The 3 volt range is of service in testing the individual storage batteries.

The 100 milli-volt range may be used to determine the "drop" over segments of the commutator of the motor or generator.

The 3 ampere range is of value in testing the current required by single lights.

The 30 ampere range will denote the current required by a complete lighting circuit or the magnitude of leaks.

The 300 ampere range is useful to determine the starting current.

The foregoing are merely a few of the tests that may be made with the instrument.

A book of instructions is furnished with the instrument showing how to make practically any electrical test on lighting and starting systems. Cautions are also given in order to prevent accidental damage to the instrument while making tests, **each \$32.50.**

With leather carry-case, provided with sling strap, to contain instrument and shunts, **extra \$4.40.**

WESTON VOLT AND AMMETER—Separate

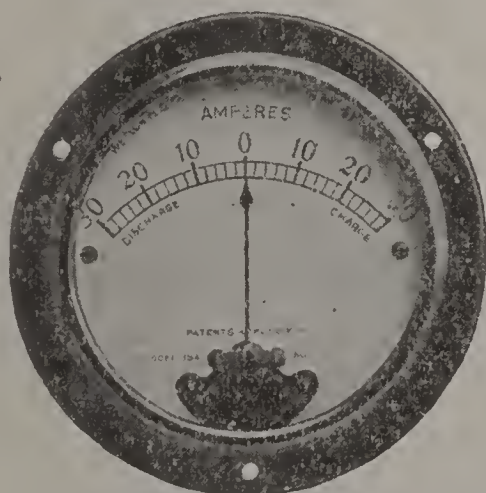


Illustration showing the Weston center zero reading, 30-0-30, Model 301 Ammeter.

These smaller instruments were primarily designed for use on the dash board but sometimes are mounted on a slanting base for ordinary test work.

For instance, the Ammeter can be used for testing the amount of current flowing to the battery from the generator, or the quantity of current consumed by the lights, horn, ignition, etc.

The Voltmeter can be used to test the voltage of the battery, generator, and for other tests.

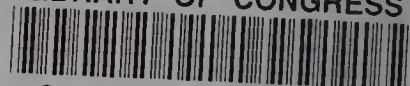
Model 301, Weston direct current Ammeter can be secured in either of the following readings on dial, with zero in the center, or to the left, and the ranges can be had for either, 3-0-3, 15-0-15, 30-0-30 amperes. **Price \$6.90.**

Model 301, Weston Voltmeter for direct current can be secured with the zero to the left of dial and with either of the readings as follows: 0 to 3, 0 to 15, 0 to 25, 0 to 30 volts. **Price \$6.90.**

NOTE: Advise if we can substitute a different reading from what you order providing we do not have meter with reading ordered in stock, or if you will allow sufficient time to secure same from factory.

Address A. L. Dyke, Elect. Dept., Granite Bldg., St. Louis, Mo.

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